LMSC-D153408

SPACE TUG ECONOMIC ANALYSIS STUDY

NAS 8-27709

FINAL REPORT
DR MA-04

VOLUME III: COST ESTIMATES

Prepared for
National Aeronautics & Space Administration
George C. Marshall Space Flight Center

Lockheed Missiles & Space Company, Inc.
Sunnyvale, California
and
Mathematica Inc.
Princeton, New Jersey

MATHEMATICA, INC.

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FOREWORD

This report summarizes work accomplished under the Space Tug Economic Analysis Study on Contract NAS8-27709. This study was performed for the NASA Marshall Space Flight Center by Lockheed Missiles & Space Company, Inc. of Sunnyvale, California, and Mathematica, Inc. of Princeton, New Jersey. The period of technical performance was nine months, starting July 26, 1971.

The NASA Contracting Officer's Representatives for this program were Lieutenant Commander William C. Stilwell (USN) and Mr. Richard L. Klan. The study team was led by Mr. Charles V. Hopkins of Lockheed and Dr. Edward Greenblat of Mathematica. Task leaders on the Lockheed team were as follows:

John P. Skratt	–	Data Integration and Interpretation
William T. Eaton	–	Payload Data and Payload Effects Analysis
Richard T. Parmley	–	Tug Definition

Other key team members included:

Anthony G. Tuffo	–	Data Mechanization and Evaluation
Zoe A. Taulbee	–	Computer Programming
Jolanta B. Forsyth	–	Payload Costs and Benefits; Tug Cost Model
Kenneth J. Lush	–	Program Costing Logic

This report is divided into three volumes as follows:

- Volume I – Executive Summary
- Volume II – Tug Concepts Analysis
- Volume III – Cost Estimates

Volume III contains two important elements of the study data base, namely the Tug costs and the entire payload data base. In addition to costs, the payload data includes weight, sizes, orbital parameters, and schedules.

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INTRODUCTION

Chapter 1
INTRODUCTION

Volume III, Cost Estimates, contains all of the Tug and unmanned-payload costs that formed the basis for the comparisons and evaluations reported in Volume II. Included in the cost data are point estimates, parametric cost data, and funding curves. Volume III also contains summaries of the technical approach, guidelines, and assumptions used to derive these costs.

The objective of the cost analysis tasks in the Space Tug Economic Analysis study was to provide a data base from which comparisons of total Tug program cost (Tug costs plus Shuttle user fees and payload costs) could be made. Because of this the cost data generated in the study had to be valid in two senses:

1. Proper overall magnitude for each configuration
2. Proper relative magnitude among the configurations

As a result the emphasis in cost analysis was on attaining relative accuracy, rather than precision, in the results.

Volume III is organized in the following way. Chapter 2 presents the important guidelines and assumptions that were used to constrain the cost analysis, and the work breakdown structure (WBS) that was used to format Tug costs. Chapters 3 through 5 then present the specific approach and key results of the cost analysis, in the following sequence:

- Chapter 3 – Orbit Injection Stages
- Chapter 4 – Reusable Space Tugs
- Chapter 5 – Payloads

Chapter 3 presents the point costs estimated for the expendable orbit injection stages. These stages are either existing vehicles or derivatives of existing vehicles, and because their sizes are established, no parametric cost data were generated for any of the OIS configurations.

Chapter 4 contains cost data for reusable Space Tugs and also for expendable versions of these Tugs. The cost data include both point estimates and parametric data. The point costs, presented in the work breakdown structure format, are for the Tug sizes and concepts that were selected for further study at the end of Phase I; RDT&E, first-unit, investment, and operations costs are presented for each Tug concept. The parametric data are in the form of direct computer plots of cost vs propellant loading, or cost vs activity level.

Chapter 5 contains payload data. This chapter comprises the complete payload data base for the study and includes payload costs, weights, dimensions, flight schedules, and orbital parameters for the unmanned spacecraft considered in this analysis. DoD payloads are described in a classified appendix to Chapter 5. This appendix is distributed on a limited basis.

ASSUMPTIONS & GUIDELINES

Chapter 2

GUIDELINES AND ASSUMPTIONS

COSTING ASSUMPTIONS

Important assumptions made in performing the cost analysis were as follows:

- Constant year dollars were used. To be consistent with other studies of the Space Transportation System, the year selected was 1970.
- The reference value for the Shuttle user fee was set at $5 million per flight. This value was used independently of the number of Shuttle flights required.
- Prime contractor fee was omitted, but subcontractor and supplier fees were accounted for in the magnitude of costs.
- Tugs were assumed to be produced at a minimum efficient rate (roughly 5 per year) to minimize the costs of sustaining a production base.
- In calculating Tug fleet requirements, it was assumed that reusable Tugs approaching the end of their nominal (design) lifetime would be used on missions requiring an expendable stage.
- The recurring costs for Tugs and OIS vehicles do not include mission-peculiar services or software.
- All RDT&E costs include expenditures for a flight test program and also costs for developing and building Shuttle interface hardware.
- No costs for Government manpower (e.g., program management, tracking network, mission control center) or Government-furnished equipment/services are included.

WORK BREAKDOWN STRUCTURE

In reporting the Tug costs, a hardware-end-item-oriented work breakdown structure (WBS) is used. This WBS (Figure 2-1) is organized in general accordance with Attachment 2 to NASA Data Requirements Description MF-030, as contained in the statement of work for this contract. The subsystem level (level-5 in MF-030) is the keystone; the study WBS carries principal Tug subsystems and important services (designated as floating items in MF-030) at this level.

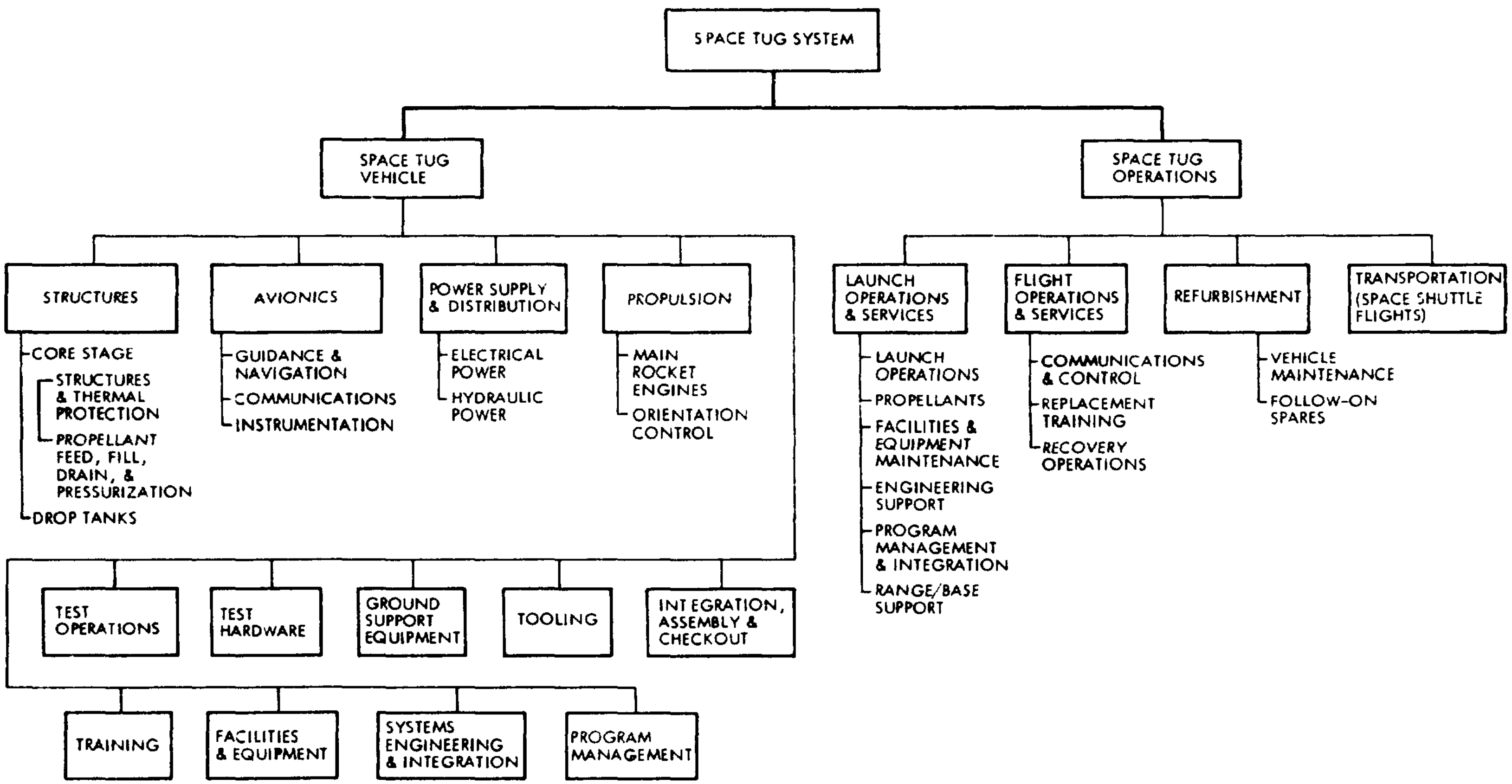

Figure 2-1. Work Breakdown Structure

In accordance with Attachment 2 cited above, the Space Tug work breakdown structure is tailored to fit the parametric cost model that was used to generate reusable Tug estimates. Consequently, this WBS has taken on some of the characteristics of the cost model, as follows:

- The subsystem groupings are fairly broad, reflecting the generalized nature of the data base
- The hardware breakdown is also intended to serve the Space Shuttle; consequently systems such as hydraulics, that are major elements of Shuttle hardware, are identified as separate line entries even though hydraulic systems are a minor cost element in space vehicles

To help reconcile the Tug costs quoted in this volume with the historical cost studies that are now nearing completion under NASA sponsorship and that use the more detailed WBS format of MF-030, the following important definitions of Space Tug WBS entries are provided:

Structures. In addition to costs for the major load-bearing structural members, this entry includes costs for thermal/meteoroid protection and propellant feed/management systems. It also includes a proportion of the analytical definition and support tasks performed at the total-vehicle level. These latter tasks, including weights, structural dynamics, loads, and thermodynamics analyses, are sometimes carried under Systems Engineering and Integration. Specific items of hardware carried under Structures are as follows:

- All integral and nonintegral propellant tanks, including bulkheads
- All load-carrying elements including thrust structure, intertank sections, and interstages
- All pressurization system elements (tanks, plumbing)
- All propellant feed, fill, and drain elements
- Tank insulation and meteoroid shielding
- Propellant utilization systems
- Propellant orientation and management systems (screens, baffles, zero-g vent devices)

Avionics. This entry refers to the major electronic systems required to guide, stabilize, monitor, and communicate with the Space Tug. Specific items included under Avionics are as follows:

- Guidance and Navigation. Includes all inertial reference elements; navigational sensors; stabilization and control electronics; rendezvous and docking electronics; and central computers (regardless of whether the computers also serve other subsystems)
- Communications. Comprises all rf equipment required to transmit information between Tug and Shuttle, or between the Tug and ground stations. Equates to Telemetry/Tracking/Command subsystem in unmanned spacecraft terminology.
- Instrumentation. Includes all sensors, data conditioning and data evaluation hardware, and associated interconnections. Also includes displays and status panels.

Power Supply and Distribution. This entry covers all hardware that produces either electrical or hydraulic/pneumatic power. Specific elements subordinate to Power Supply and Distribution are as follows:

- Electrical Power. Includes power supply (e.g., batteries, fuel cells), power conversion, and power distribution (electrical harnessing, junction boxes).
- Hydraulic Power. Includes power packages, accumulators, lines, and actuators (not used with reusable Tug because these vehicles have electromechanical gimbal actuators)

Propulsion. This WBS entry covers all Tug propulsive systems: primary, secondary, and orientation control. It includes engines for all systems, and feed/fill/drain/ pressurization functions for the secondary and orientation control systems. Systems subordinate to Propulsion are as follows:

- Main Rocket Engine. Includes the engine and its electromechanical thrust vector control mechanism. Excludes main stage tankage, pressurization, plumbing, and propellant management devices
- Orientation Control. Equates to Reaction Control or Attitude Control systems in other nomenclature. Comprises engines, tanks, and all feed functions.

Integration, Assembly and Checkout. This entry covers all stages between the completion of subsystems hardware and the delivery of the completed Tug. It includes the following steps:

- Final Assembly. Installation of subsystems, assembly of major segments, alignment, and checkout
- Acceptance Test. Functional testing in specified environments, and all supporting test plans, quality assurance, and documentation activities

Tooling. This entry includes all costs associated with tooling and special test equipment (STE). It specifically comprises the cost of planning, design, fabrication, assembly, installation, modification, maintenance, and rework of all tooling and STE, as follows:

- Tooling. Includes assembly tools, dies, jigs, fixtures, master forms, gauges, and in-plant handling equipment
- Special Test Equipment. Includes simulators, test sets, and other hardware designed to accomplish the in-process testing of avionics equipment

Ground Support Equipment. This entry includes the cost of development, engineering, testing, and production of all ground-based equipment required to support the Space Tug during test (development and acceptance), launch, and refurbishment. It comprises checkout equipment, ground handling and servicing equipment, and launch monitor and control equipment.

Test Hardware. This WBS entry covers all major test articles used during the RDT&E phase of the Space Tug program, including ground- and flight-test articles as follows:

- Ground Test Hardware. Includes the cost of manufacturing mockups and the complete vehicle elements needed for structural/dynamic testing, propulsion system integration testing, and all-systems testing. Hardware for subsystems development and qualification test is excluded from this element but is included with the appropriate subsystem design and development costs.
- Flight Test Hardware. Includes the fabrication, assembly and acceptance-test costs of all flight test articles.

Test Operations. This entry comprises the direct costs of conducting all system-level ground and flight tests. It includes manpower for test planning, test operations, and data reduction/evaluation; it also includes all consumables used during these tests, particularly propellants and gases. Specific test operations cost elements are as follows:

- Ground Test. Includes only system-level tests such as structures, dynamics, cold flow, and hot firings. Excludes subsystem level tests (these are carried under the appropriate subsystem entries in the WBS).
- Flight Test. Includes the costs for Tug launch, flight, and refurbishment operations in the RDT&E phase; flight-test data reduction and evaluation; and Space Shuttle user fees for the test flights.

Training. This entry covers the costs of initial personnel-training activities, design and fabrication of simulators and teaching aids, and development of curricula. The skills taught in the training program include Shuttle crew operations for Tug checkout, deployment, and retrieval; mission-control crew functions; and launch base operations with the Tug.

Facilities and Equipment. This entry covers the costs incurred to design, build, and activate new facilities for the Space Tug. Because existing facilities are sufficient for manufacturing and testing of the Tug, and because Shuttle launch facilities will serve both vehicles, the only facilities required for the Tug are refurbishment and maintenance shops.

Systems Engineering and Integration. This entry covers two separate elements from the Tug cost model, namely Systems Engineering and Vehicle Integration. Systems Engineering is defined in the model to include: establishing engineering design characteristics; determining criteria for design review; establishing procedures for testing components, subsystems, or vehicle elements; integration of ground and flight test results into the vehicle design; developing procedures for vehicle maintenance; quality planning and administrative engineering. Vehicle Integration is defined as the cost of engineering and development activities relating to the definition of vehicle and payload interfaces, and the proper integration of the Tug with other vehicle system elements. Some of the costs identified under Systems Engineering and Integration in historical studies are prorated to the subsystems (particularly Structures) in the Tug cost model.

Program Management. This entry covers the costs for prime-contractor direct costs associated with managing the Tug program. It includes the cost of maintaining a project office to perform such functions as overall technical direction and coordination; program control (schedules and costs); and documentation (reports, specifications, manuals). This WBS entry specifically excludes salaries of managers and executives working for the contractor; these persons are indirect employees.

Launch Operations and Services. This WBS entry covers all events between the time that a new Tug arrives at the launch site (or a refurbished Tug is delivered from the maintenance shops) to the time the Shuttle is launched. Specific cost elements subordinate to this entry are as follows:

- Launch Operations. Includes the costs for manpower to perform receiving inspection, Tug checkout, payload mating and checkout, prelaunch handling (in support of Shuttle crew), Tug propellant loading, and participation in the countdown
- Propellants. Comprises costs for main-stage and orientation-control propellants, and all gases, flushing compounds, and miscellaneous fluids.
- Facilities and Equipment Maintenance. Refers to the recurring costs for maintenance and operation of all Tug facilities and GSE at the launch site
- Engineering Support. Includes sustaining engineering, liaison and engineering services activities performed at the contractor's plant and at the launch site during the Operations phase of the Tug program
- Program Management and Integration. Comprises costs for administration and management services in support of the Tug launch-base activities, e.g., cost and schedule control and reporting, management, and clerical salaries
- Range/Base Support. Refers to the costs of services (usually provided by a support contractor) that support the direct launch and maintenance operations. Includes range safety and control; shop and repair services; standards and instrument calibration; and base services such as food, mail, reproduction, security, fire protection, utilities, communications, transportation, health and custodial services, and logistics support.

Flight Operations and Services. This WBS entry covers all Tug activities from launch of the Shuttle through recovery of the Tug at the completion of its mission. Specific cost elements subordinate to this study are as follows:

- Communications and Control. Also known as Mission Control. Includes costs associated with ground command, control, and tracking from Tug launch through mission completion and return. Includes such functions as flight control, telemetry, communications, data processing and data analysis.

- Replacement Training. Includes the cost of training qualified Shuttle and mission-control crew personnel, to replace those lost by rotation or attrition, in order to maintain manning at levels necessary to meet flight and ground operation schedules.
- Recovery Operations. Includes the cost of assisting in recovery operations, propellant purging, vehicle deactivation and servicing. Assumes that the Tug returns within the Shuttle bay.

Refurbishment. This WBS entry covers all activities between the time when a deactivated Tug is returned from the flight cycle and the time that this Tug is delivered to the launch facility ready for a new prelaunch cycle. Cost elements specifically included under this entry are as follows:

- Vehicle Maintenance. Includes the cost to restore a reusable Tug after mission completion to a readiness condition for subsequent missions. All costs pertaining to inspection, maintenance, replacement of necessary parts, repair (as necessary) of components, and testing are included. This activity is completed when the vehicle is ready for launch operations. Includes both normal turnaround between flights and regularly scheduled overhauls.
- Follow-on Spares. Refers to the costs of spare parts and components produced to replenish initial spare stocks in support of Tug maintenance and overhaul, both scheduled and unscheduled.

Transportation. This WBS entry accumulates costs for Space Shuttle user fees incurred in delivering the Tug and its payload to low earth orbit. A baseline user fee of $5 million per flight was used in this study.

ORBIT INJECTION STAGE COSTS

Chapter 3
ORBIT INJECTION STAGES

This chapter reports cost estimates derived for the orbit injection stage (OIS) class of Space Tugs. The OISs are existing stages, or growth versions of existing stages, modified for Shuttle compatibility and flown only in the expendable mode. Important aspects of the OIS cost analysis are as follows:

- Point costs were derived rather than parametric data because the OIS sizes were generally well established
- The emphasis in costing was on deriving estimates that were comparable between concepts, especially for the unit production and operations costs that drive OIS total-program expenditure levels.
- The recurring production costs cited for OIS concepts are average unit values at a given production rate. Theoretical first-unit costs were not presented because the OIS concepts represent mature space-vehicle designs whose costs are influenced by production rate rather than learning effects.

APPROACH

The estimates of OIS costs were derived using a two-step procedure. First, a set of preliminary estimates was made so cost comparisons could be made using the STAR/ANNEX computer program. The unit costs were estimated on the basis of current pricing data for the existing Agena and Centaur stages. RDT&E costs for the conversion of those stages to OIS configurations were estimated by extrapolation from comparable development programs.

Then, as the NASA-funded studies of Agena and Centaur OIS vehicles (NAS9-11949 and NAS3-14389, respectively) were completed, the results of the more detailed estimates formulated on these contracts were compared with the preliminary values. Differences between the two sets of estimates were evaluated and reconciled.

The results of this analysis are presented in the following sections.

OIS COST DATA

Agena

The preliminary cost estimates used to represent the existing Agena (modified for service as an orbit injection stage) were as follows:

Recurring Production	$ 2.29 Milli
Recurring Operations	$ 0.68 Mill.
RDT&E	$43.90 Millic

The recurring costs were calculated assuming the production and launch rates needed to sustain a best-mix family of Agena and Centaur (i.e., 378 Agenas and 116 Centaurs) over the 12 year mission model. A tabular breakout of Agena OIS recurring production costs formulated in this analysis is presented in Table 3-1.

Table 3-1. AVERAGE RECURRING PRODUCTION COST FOR THE AGENA OIS

Item	Cost ($ Millions)
Structure	(0.26/)
Structures and Thermal Protection	0.191
Propellant Feed and Management	0.076
Avionics	(0.809)
Guidance and Navigation	0.747
Communications / Instrumentation	0.062
Power Supply and Distribution	(0.104)
Electrical	0.076
Hydraulic	0.028
Propulsion	(0.523)
Main Rocket Engine	0.468
Orientation Control	0.055
Integration, Assembly, Checkout, and Test	0.225
Program Management	0.061
Systems Engineering	0.245
Spares	0.058
Total	2.292

In the Shuttle/Agena study performed by Lockheed for NASA/MSC (NAS9-11949) these costs were completely recalculated using a rigorous bottom-up estimating methodology. In general, the recalculated costs were found to be in agreement with the preliminary values once rate differences were accounted for. Specific comparisons of the cost data are as follows:

- Recurring Production. The detailed analysis of Agena OIS unit production costs gave an estimate of $3.41 million per vehicle at a manufacturing rate of six per year; projected cost reductions with higher rates are shown in Figure 3-1. When extrapolated to the Agena/Centaur best-mix launch rate of over 30 Agenas per year, the unit costs drop to around $2.2 million each; this is in excellent agreement with the preliminary estimate.
- Recurring Operations. The detailed cost analysis resulted in an estimate of $780,000 per flight for recurring operations (launch and flight operations/services) at a rate of 6 launches per year. This compares to the preliminary estimate of $682,000 at over 30 Agena OIS launches per year. When measured against other Agena launch rate/cost projections, the original estimate of $682,000 at more than 30 launches per year is considered quite conservative.
- RDT&E. In the detailed Agena OIS cost analysis it was estimated that development of the Agena for service as an orbit injection stage (including fabrication of six sets of Shuttle interface hardware and one flight test article) would cost $40.469 million. This compares to an original estimate of $43.9 million, a variation of less than 10 percent.

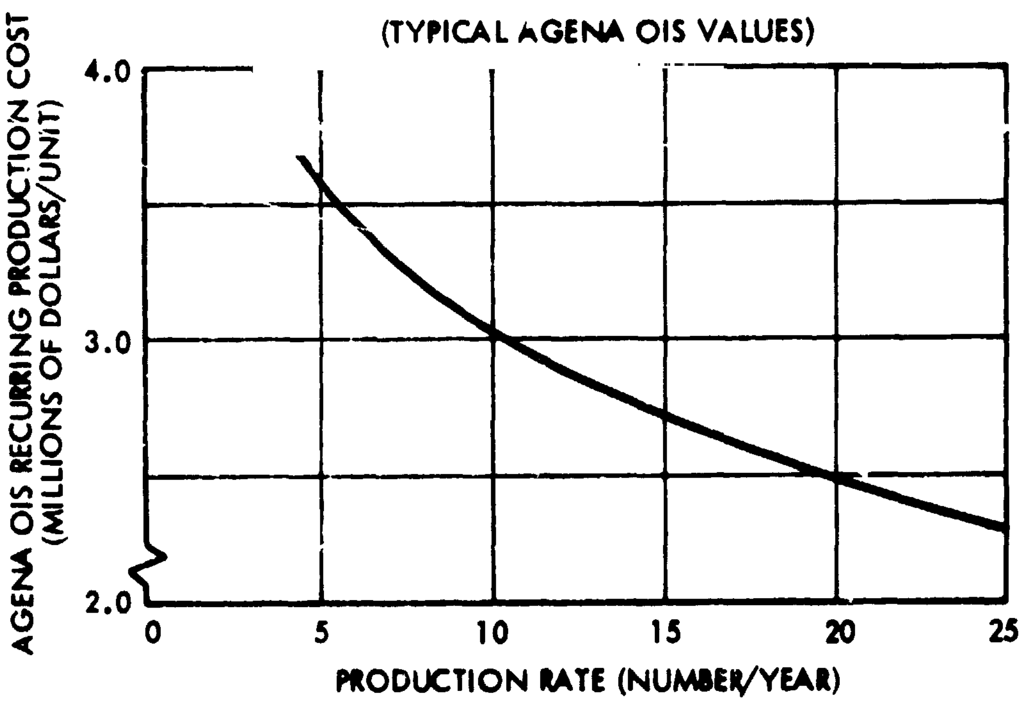

Figure. 3-1 Typical Unit Cost vs Rate Curve for Agena OIS

In summary the preliminary values used for the Agena OIS in cost comparisons were equivalent to the refined estimates, or were slightly more conservative.

Large Tank Agena (LTA)

The preliminary estimates used to represent the Large Tank Agena OIS in cost comparisons were as follows:

Recurring Production	$ 2.59 Million
Recurring Operations	$ 0.68 Million
RDT&E	$51.90 Million

The recurring costs were based on production and launch rates needed to sustain the 12 year mission model using exclusively the Large Tank Agena OIS, that is, rates in excess of 40 per year. The RDT&E costs were based on a development program in which the OIS development would proceed directly to the large-tank version of Agena rather than evolving from a 5-foot diameter Agena OIS.

In the refined cost analysis performed under contract NAS9-11949 the LTA orbit injection stages were estimated at the same level of detail as the Agena OIS. Comparing the results of this refined analysis with the preliminary estimates just discussed, the following specific observations can be made:

- Recurring Production. In the detailed cost analysis, unit production costs for the LTA orbit injection stage were estimated at $3.86 million for a manufacturing rate of six vehicles per year, whereas the preliminary estimate was $2.59 million based on a production rate of 40 vehicles per year. Although no unit-cost-versus-rate chart was formulated for the LTA orbit injection stage, the $2.59 million cost at 40 per year appears consistent with the $3.86 million at six per year if the trend of the baseline Agena rate curve applies.
- Recurring Operations. The derived operations cost of the LTA OIS was $844,000 per launch at six flights per year. This compares with the $682,000 preliminary estimate based on 40 launches per year. In reconciling these two values it appears that $682,000 is a reasonable-to-slightly-conservative extrapolation of the operations costs at over 40 launches per year.
- RDT&E. The RDT&E cost for a Large Tank Agena OIS was estimated at $47.662 million in the detailed cost analysis and at $51.9 million in the preliminary, a difference of less than 10 percent.

In summary, the LTA orbit injection stage costs as used in the preliminary comparisons agree reasonably well with the detailed estimates derived in the Agena OIS study.

Centaur

The preliminary Centaur cost estimates used by Lockheed to compare OIS concepts were as follows:

Recurring Production	$ 4.75 Million
Recurring Operations	$ 1.20 Million
RDT&E	$61.50 Million

The recurring costs were calculated assuming the production and launch rates needed to sustain a best-mix family of Agena and Centaur (116 Centaurs over 12 years). A tabular breakout of Centaur OIS recurring-production costs, as used in the Tug concept comparisons, is presented in Table 3-2.

Table 3-2. AVERAGE RECURRING PRODUCTION COST FOR CENTAUR OIS

Item	Cost ($ Millions)
Structure	(1.462)
Structures and Thermal Protection	0.662
Propellant Feed and Management	0.800
Avionics	(1.341)
Guidance and Navigation	1.056
Communications / Instrumentation	0.285
Power Supply and Distribution	(0.197)
Electrical	0.095
Hydraulic	0.102
Propulsion	(1.411)
Main Rocket Engines	0.880
Orientation Control	0.531
Integration, Assembly, Checkout and Test	0.335
Program Management	*
Systems Engineering	*
Total	4.746

*Distributed among Subsystems

In the study "Compatibility of a Cryogenic Upper Stage with Space Shuttle," performed by General Dynamics/Convair Aerospace for NASA Lewis Research Center (contract NAS3-14389), a systematic analysis of Centaur OIS costs was conducted. The results of this analysis show that there is general agreement between these costs and Lockheed preliminary estimates in all areas except RDT&E funding requirements. Specific comparisons are as follows:

- Recurring Production. The recurring production costs estimated by Convair Aerospace totaled $5.24 million each at a production rate of four vehicles per year. A curve of the expected Centaur OIS cost versus production rate was also formulated by Convair; this curve is presented as the upper plot in Figure 3-2. When extrapolated to the Centaur launch rate for an Agena/Centaur best-mix (approximately nine per year) the unit cost of a Centaur OIS declines to about $4.7 million, which is in excellent agreement with the preliminary estimate.
- Recurring Operations. The detailed Convair Aerospace cost analysis estimated Centaur OIS recurring operations costs at $1.69 million for a launch rate of four per year, with cost reduction for higher rates as shown in the lower curve of Figure 3-2. When extrapolated to nine launches per year this estimate drops to approximately $1.2 million, which agrees exactly with the preliminary estimate. The Convair costs, however, exclude propellants and gases.
- RDT&E. Convair Aerospace estimated the cost to modify the Centaur D-1T to an orbit injection stage configuration at $30.6 million. This estimate is based on the assumptions that there would be no flight test of the Centaur OIS, and that two operational sets of Shuttle interface equipment would be procured. This estimate differs by a factor of two with the preliminary costs estimated by Lockheed. Obvious sources of difference between the two values are (1) the inclusion of a flight test program in the Lockheed estimate and (2) the difference in amount of operational Shuttle interface equipment procured (six sets assumed by Lockheed and two by Convair Aerospace). The other variances apparently arise from differing interpretations of relative complexity in Centaur modification to the OIS configuration.

In summary, the preliminary estimates for Centaur OIS used in cost comparisons were in agreement with Convair Aerospace estimates, except in the area of RDT&E cost. However, inasmuch as development costs were not a factor in the economic ranking of OIS concepts, the importance of the RDT&E cost discrepancies was minimal.

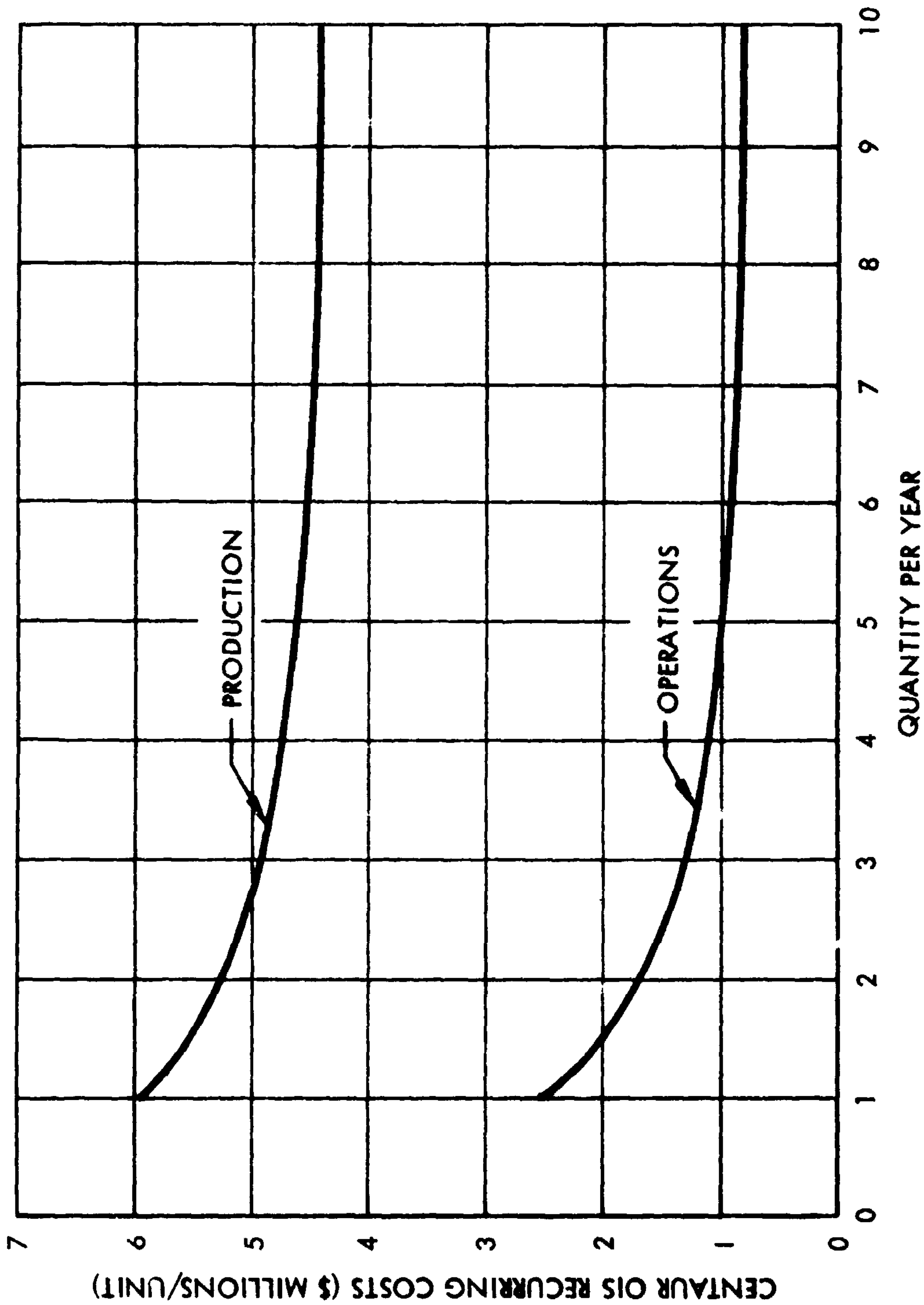

Figure 3-2. Typical Centaur OIS Recurring Cost vs Rate Curve

Growth Tank Centaur

The preliminary cost estimates formulated by Lockheed for the Growth Tank (GT) Centaur were as follows:

Recurring Production	$ 5.25 Million
Recurring Operations	$ 1.20 Million
RDT&E	$65.50 Million

The recurring costs were calculated assuming production and launch rates of nine vehicles per year.

Under contract NAS3-14389, Convair Aerospace estimated, on a preliminary basis the costs of a Growth Tank Centaur orbit injection stage. The results of this analysis may be compared to the preliminary costs as follows:

- Recurring Production. Growth Tank Centaur OIS recurring production costs were estimated to be $5.5 million at a rate of four per year. This contrasts with Lockheed's estimate of $5.25 million at a production rate of nine vehicles per year. No cost-versus-rate curve was generated by Convair Aerospace for the GT Centaur OIS; however, based on Centaur trends it is estimated that the preliminary values are about $200,000 higher at nine per year than an extrapolation of the Convair estimate.
- Recurring Operations. Convair Aerospace did not identify any increase in recurring-operations costs in going from the D-1T to the GT version of a Centaur OIS. However, the Convair estimates specifically exclude propellants and gases, one of the launch cost items that would definitely increase for the larger GT Centaur. After adjusting the Convair estimates of $1.69 million per launch (at four per year) for rate variations there results a cost identical to the preliminary value of $1.2 million. Both values are low by the cost of propellants and gases.
- RDT&E. The RDT&E cost estimated by Convair Aerospace for developing an OIS to the GT Centaur configuration (without the intervening step of a D-1T Centaur version) is $36.2 million. This compares to the Lockheed preliminary estimate of $65.5 million. The same factors that were discussed with relation to the differences between Convair and Lockheed estimates for the D-1T Centaur OIS apply here.

In summary, the comparative costs used by Lockheed in the Space Tug Economic Analysis for the GT Centaur OIS were slightly higher in recurring-production cost than Convair's value. Both values were identical in recurring operations, but are

probably low because of propellant/gas requirements. The RDT&E costs estimated by Convair were just over half the value estimated by Lockheed; the differences reflect varying assumptions and differing estimates of the development complexity.

FUNDING REQUIREMENTS

Tug funding requirements by year were calculated for all OIS configurations as part of the STAR/ANNEX program. Standard statistical spread functions were used to distribute costs over the applicable time spans. No smoothing of expenditure curves was performed.

To typify the funding pattern for the entire class of orbit injection stages, the annual expenditure requirements of a promising OIS configuration (the Large Tank Agena) have been plotted by fiscal year. This graph is presented as Figure 3-3. The funding requirements shown here represent expenditures for RDT&E, recurring production (investment in the expendable Tug fleet), and recurring operations for the 12 year duration of the mission model. These costs specifically exclude Space Shuttle user fee, and all payload costs. The characteristic funding curve for an orbit injection stage features low early-year funding ($20 million peak for LTA in FY 1976-77); this is of importance because peak Shuttle funding requirements occur in this same general time period. However, Large Tank Agena OIS funding requirements increase to a level of about $150 million during the operational period. The total funding for the Large Tank Agena OIS amounts to $1.64 billion.

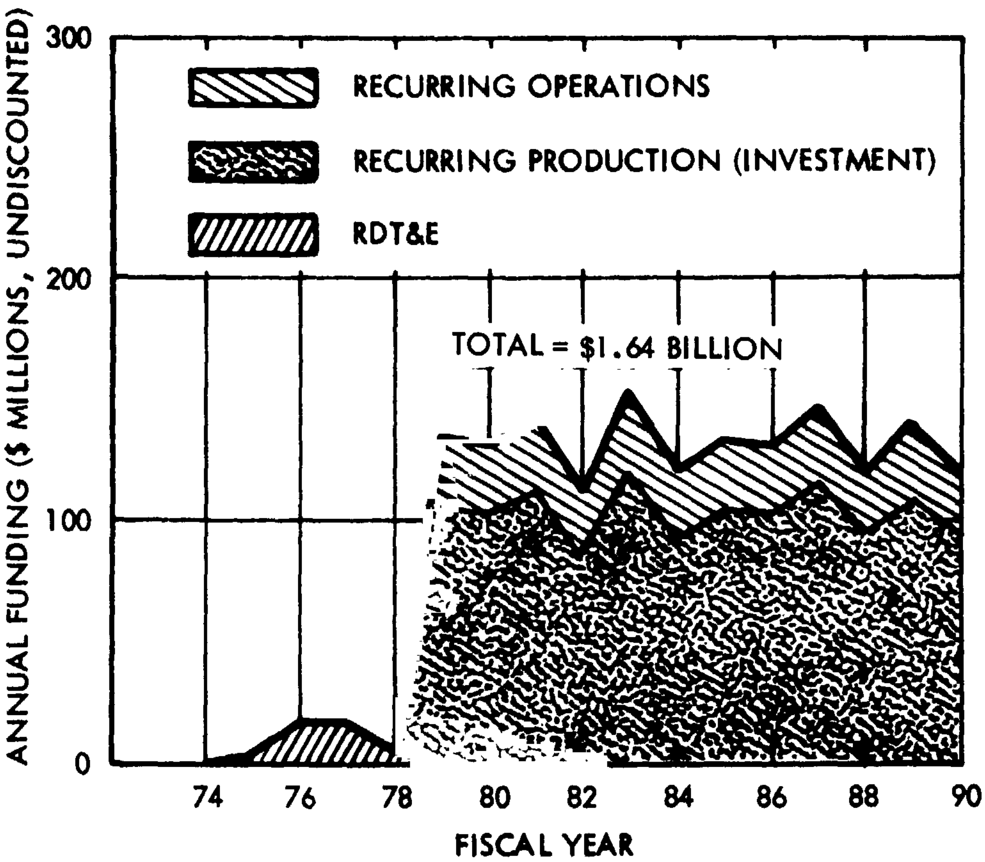

Figure 3-3. Large Tank Agena (OIS) Funding Requirements

REUSABLE SPACE TUG COSTS

Chapter 4
REUSABLE SPACE TUGS

Chapter 4 reports the cost estimates derived for the general class of reusable Space Tugs (both reusable and expendable versions of the Tugs). This chapter is organized in the following manner. First, the approach used in costing reusable Tugs is summarized briefly. Then the cost data for specific Tug concepts are presented in detail. The sequence of data follows a time-phased order, as follows:

1. RDT&E costs
2. Investment phase costs (including theoretical first-unit values)
3. Operations costs

Within each phase, the costs are compared by concept in the following sequence:

- Single-stage, LO_2/LH_2
- Single-stage, LF_2/LH_2
- Single-stage FLOX/CH_4
- Stage-and-one-half, LO_2/LH_2

Point costs are given (in the WBS format) for the reference Tug sizes selected at the end of Phase I and then parametric cost curves are given to extend the data across the spectrum of Tug sizes. In the first-unit cost data, parametric estimates are presented for both expendable and reusable versions of the Tug concepts.

The final section of Chapter 4 discusses funding requirements for these reusable Tugs.

APPROACH

The costing of reusable Space Tug concepts was accomplished by the use of a parametric cost model that was automated within the logic of the STAR/ANNEX computer program. This cost model was based on an earlier model derived by Aerospace Corporation [1]

[1]STS Cost Methodology, Volume II, "Orbit-to-Orbit Shuttle Cost Methodology," Aerospace Corp., TOR-0059(6759-04)-1, August 31, 1970, as revised.

for chemical orbit-to-orbit shuttle systems. This basic model was augmented as other data from NASA or Lockheed sources became available. Certain of the cost estimating relationships in the model were replaced and certain of the complexity factors were modified.

The resulting model reflects the most detailed estimates attainable with the given historical base. In this model costs for major categories of subsystems and services are estimated using cost estimating relationships (CERs). These CERs relate cost to technical parameters (primarily weight); they are based on broad historical data for launch vehicles, manned and unmanned spacecraft, and liquid-propellant ballistic missiles. Because the data base is so broad and the data are in inconsistent formats, the categories of costs for CERs are also very broad. For example the CER for Structures includes in addition to load-carrying structural members, insulation (thermal protection), propellant feed/fill/drain, and pressurization systems; it also includes some share of overall-system design and sustaining-engineering costs.

Any costs not estimated directly by CERs are derived by other mathematical relationships that take into account both the hardware costs (as derived from the CERs) and external factors such as activity level.

Complexity factors are applied to the resulting costs, to account for differences of propellant type, design concept, or lifetime. In addition, learning curve factors are applied to the theoretical first-unit costs to adjust for production improvement effects; these learning factors are also assumed to compensate for size-of-buy efficiencies.

The output of this model is a breakdown of reusable Tug dollar estimates to major cost-producing elements for the RDT&E, investment, and operations phases. NASA is now in the process of building a cost data bank with far greater detail than the sources used for this Tug cost model; moreover, these studies are being conducted with a common reference format so the results will be more directly comparable. When the data bank is complete, a Tug cost model of far finer detail will become feasible.

RDT&E COSTS

RDT&E COSTS

The costs for the research, development, test, and evaluation (RDT&E) phase of the reusable Space Tug program are presented here. The RDT&E phase costs include all nonrecurring expenditures that would be made for the Space Tug program from the start of Phase C (Design) through the date of initial operational capability (IOC) for the full Tug system. Specific activities included in this phase are design and development of the Tug system; fabrication of ground- and flight-test hardware; test operations (ground and flight); design and fabrication of tooling and ground support equipment sufficient for the RDT&E phase; and training.

Important assumptions governing these RDT&E costs are as follows:

- A total of five equivalent vehicles was costed under the WBS entry for Test Hardware; of these, three were ground-test articles and two were flight-test articles.
- Test Operations costs include 20 equivalent full-duration firings.
- Costs for Concept Feasibility and Definition phases of the program (Phases A and B, respectively, under Phased Project Planning criteria) were omitted. Technology program costs (normally funded under Supporting Research and Technology expenditures) were likewise omitted.

For definition of the individual WBS entries, refer to Chapter 2.

Single-Stage LO_2/LH_2 Tug RDT&E Costs

The RDT&E costs for single-stage, reusable, ground-based Space Tug configurations that use LO_2/LH_2 propellants are presented in this section. Point estimates for the RDT&E costs of two reference sizes (36,300 lb and 50,200 lb propellant loading) of this class of Tugs are presented in Tables 4-1 and 4-2, respectively.

Parametric RDT&E cost data for single-stage LO_2/LH_2 reusable Tugs are presented in Figures 4-1 through 4-4. Figure 4-1 is a summary of RDT&E cost as a function of propellant loading. The variation in cost is caused solely by the overall size effects (e.g., larger tooling, costlier test articles, increased test-phase propellants). The primary breakdown of costs in Figure 4-1 follows a nomenclature peculiar to the cost model. Each of the cost entries on this chart is further broken down as follows:

- Airframe. Consists of the structures, avionics, and power subsystems. The parametric breakdown of these costs is given in Figure 4-2.
- Propulsion. Consists of main-engine and orientation-control systems. The breakdown of these costs is presented in Figure 4-3.
- Miscellany. Equates to floating-item (services) type costs. The breakdown of these costs is presented in Figure 4-4.

Table 4-1. RDT&E COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG
(W_P = 36.3K)

Item	Cost ($ millions)
Structure	87.191
Avionics	(28.998)
Guidance and Navigation	16.834
Communications	9.991
Instrumentation	2.173
Power Supply and Distribution	(21.010)
Electrical Power	21.010
Propulsion	(133.775)
Main Rocket Engine	105.876
Orientation Control	27.899
Initial Tooling	23.499
Ground Support Equipment	11.678
Test Hardware	80.047
Test Operations	35.082
Training	4.801
Systems Engineering and Integration	22.406
Program Management	25.177
Facilities	36.284
Total	509.948

Table 4-2. RDT&E COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P 50.2K)

Item	Cost ($ millions)
Structure	95.832
Avionics	(28.998)
Guidance and Navigation	16.834
Communications	9.991
Instrumentation	2.173
Power Supply and Distribution	(21.010)
Electrical Power	21.010
Propulsion	(134.106)
Main Rocket Engine	105.876
Orientation Control	28.230
Initial Tooling	26.334
Ground Support Equipment	12.677
Test Hardware	81.941
Test Operations	35.559
Training	4.839
Systems Engineering and Integration	23.355
Program Management	26.444
Facilities	37.083
Total	528.178

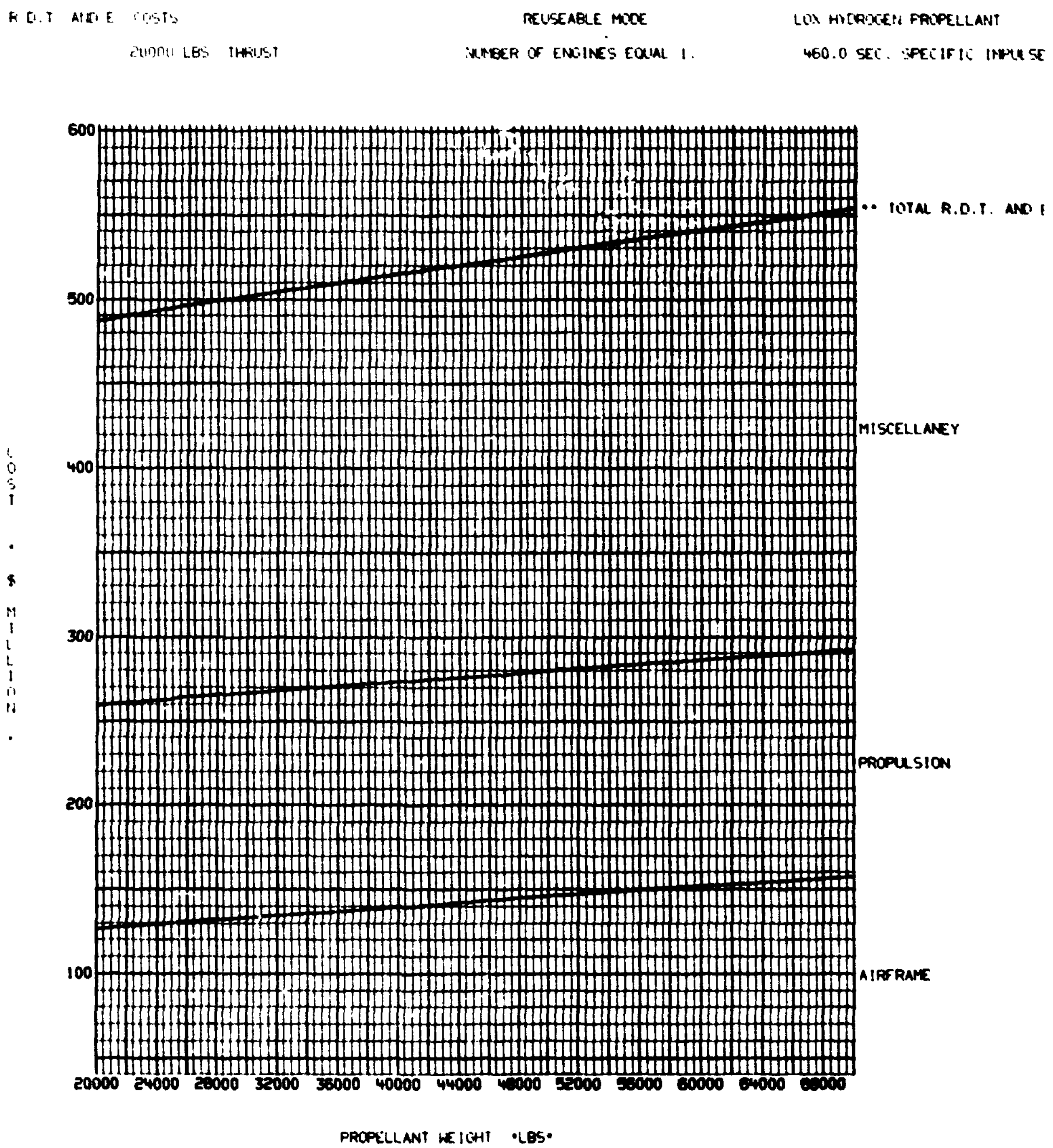

Figure 4-1. Parametric RDT&E Costs for LO_2/LH_2 Single-Stage, Ground-Based Tugs

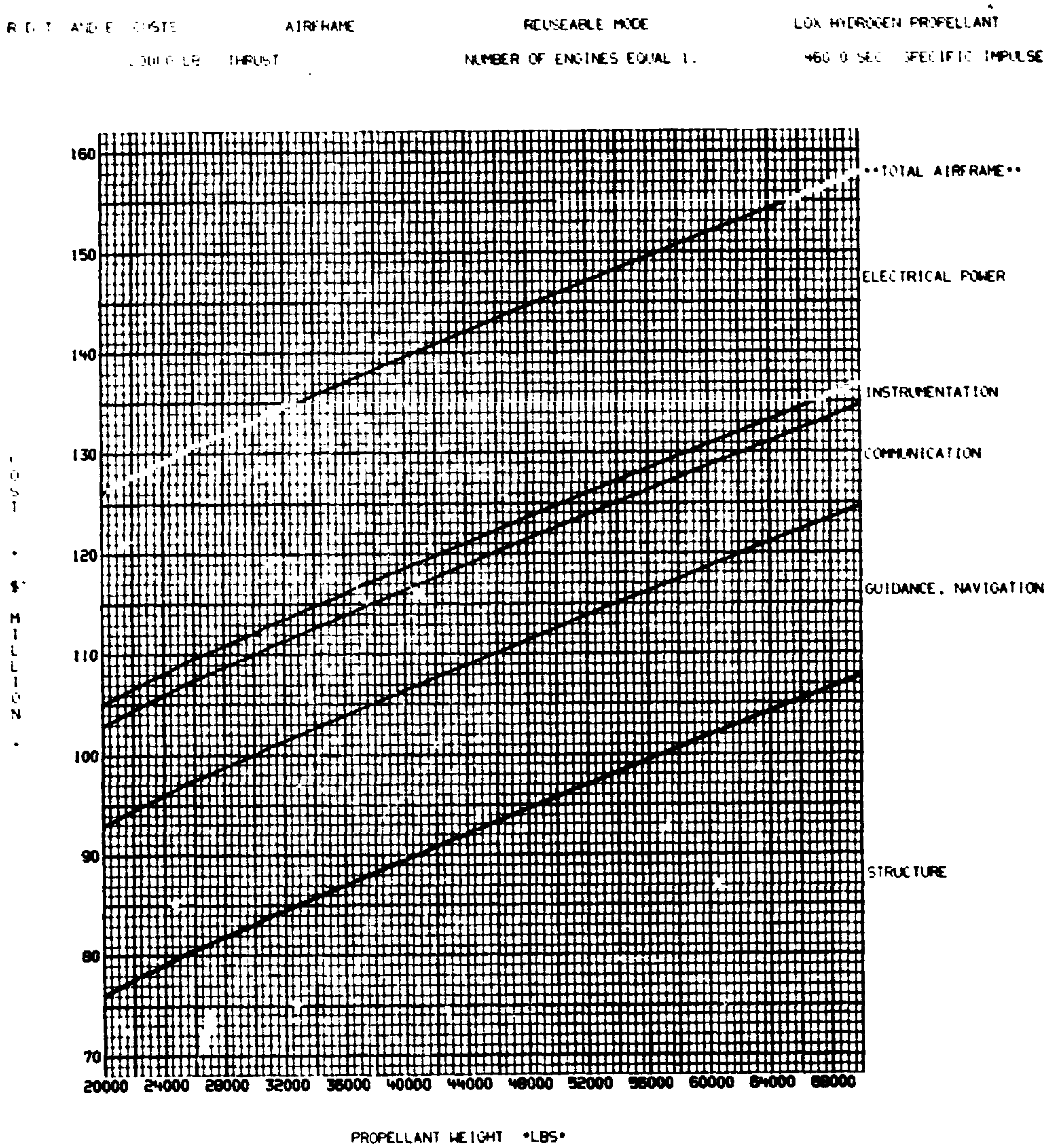

Figure 4-2. Parametric Avionics, Power and Structure RDT&E Costs, LO_2/LH_2 Single-Stage, Ground Based Tugs

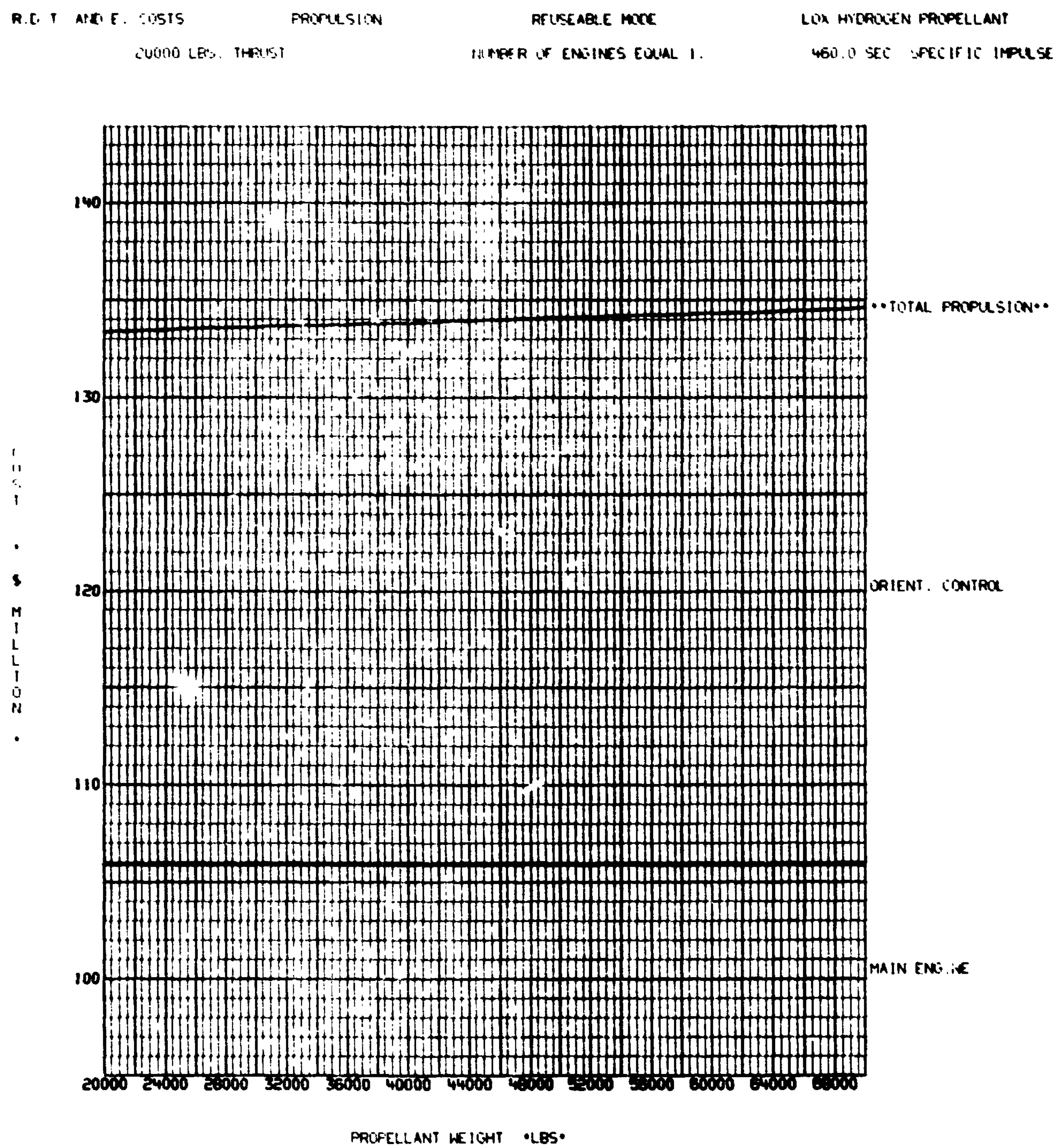

Figure 4-3. Parametric Propulsion RDT&E Costs, LO_2/LH_2 Single-Stage, Ground Based Tugs

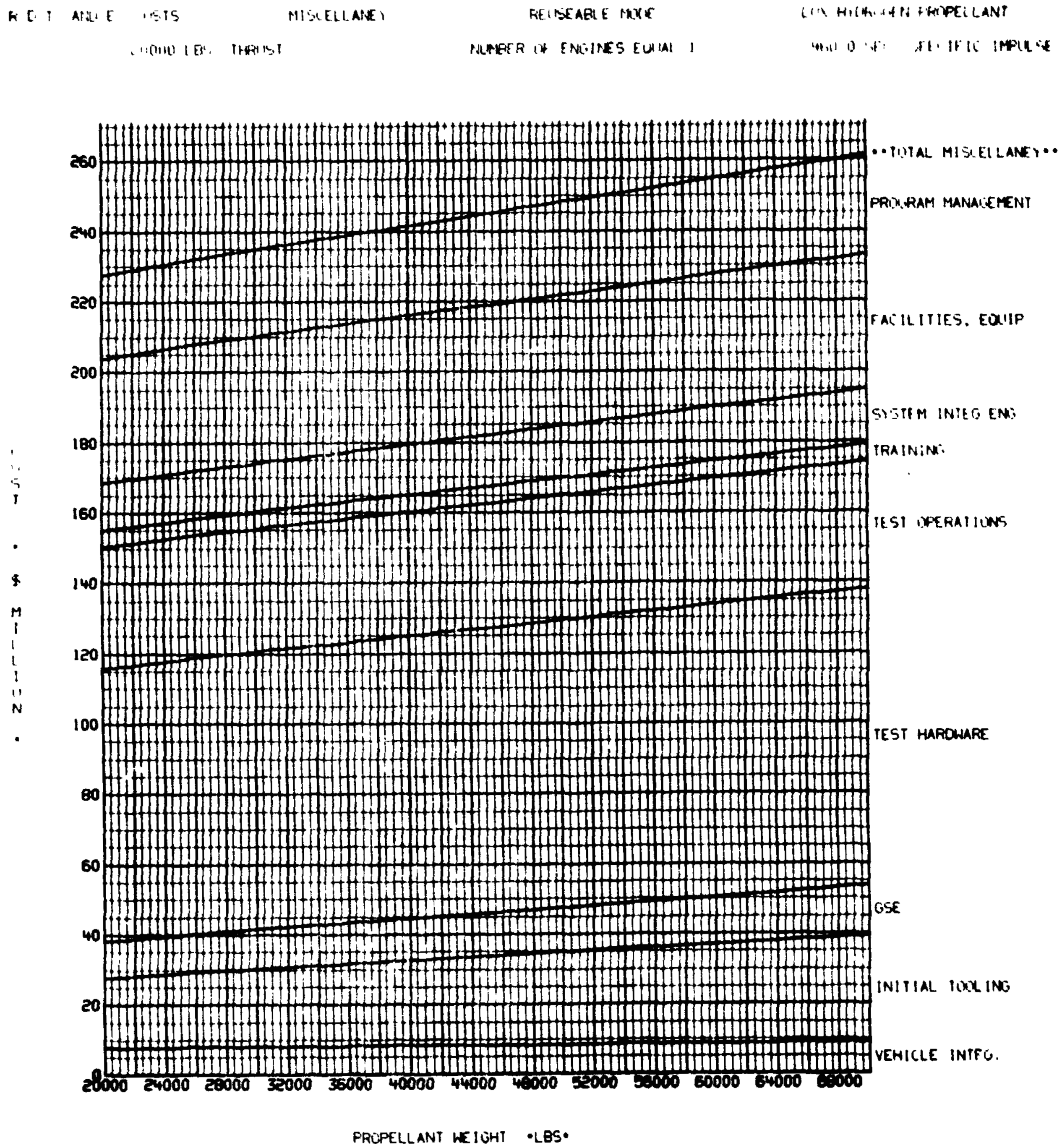

Figure 4-4. Parametric Floating-Item RDT&E Costs, LO_2/LH_2 Single-Stage, Ground-Based Tugs

Single-Stage LF_2/LH_2 Tug RDT&E Costs

This section presents RDT&E costs for single-stage, ground-based, reusable Space Tugs that use LF_2/LH_2 propellants. A point estimate for the RDT&E cost of the one reference LF_2/LH_2 Tug concept, sized at 47,800 lb propellant loading, is presented in Table 4-3.

Parametric cost data for the RDT&E costs of single-stage LF_2/LH_2 reusable Space Tugs are presented in Figures 4-5 through 4-8. The general format of these graphs is similar to the LO_2/LH_2 series presented in the previous section; that is, the total RDT&E cost curves are given first, followed by detailed parametric breakdowns of the RDT&E cost elements.

Table 4-3. RDT&E COST FOR LF_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P ~ 47.8K)

Item	Cost ($ millions)
Structure	91.649
Avionics	(28.998)
Guidance and Navigation	16.834
Communications	9.991
Instrumentation	2.173
Power Supply and Distribution	(21.010)
Electrical Power	21.010
Propulsion	(189.563)
Main Rocket Engine	161.334
Orientation Control	28.229
Initial Tooling	23.087
Ground Support Equipment	11.548
Test Hardware	82.835
Test Operations	35.342
Training	4.857
Systems Engineering and Integration	25.164
Program Management	25.959
Facilities	36.181
Total	576.193

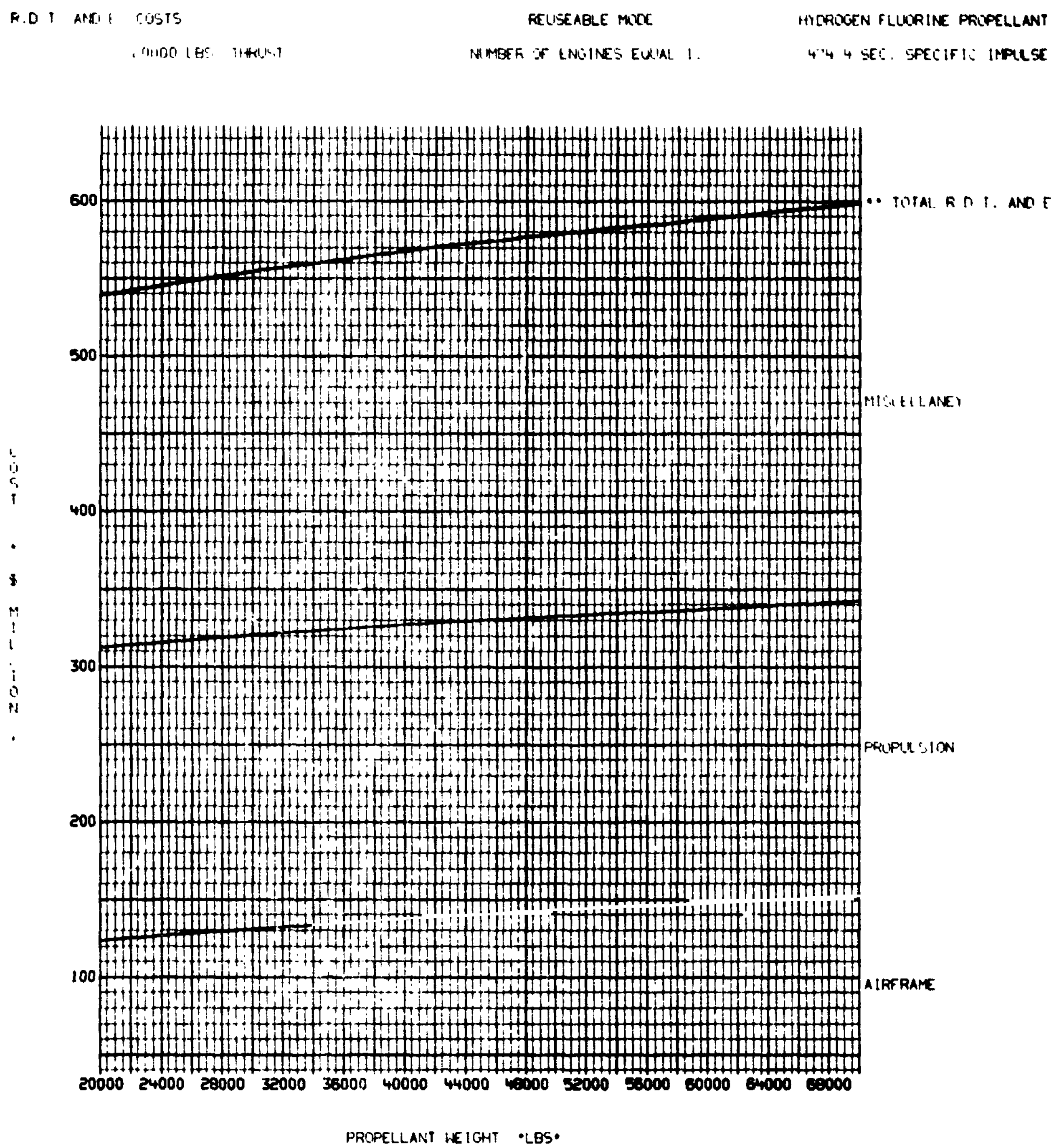

Figure 4-5. Parametric RDT&E Costs for LF_2/LH_2 Single-Stage, Ground-Based Tugs

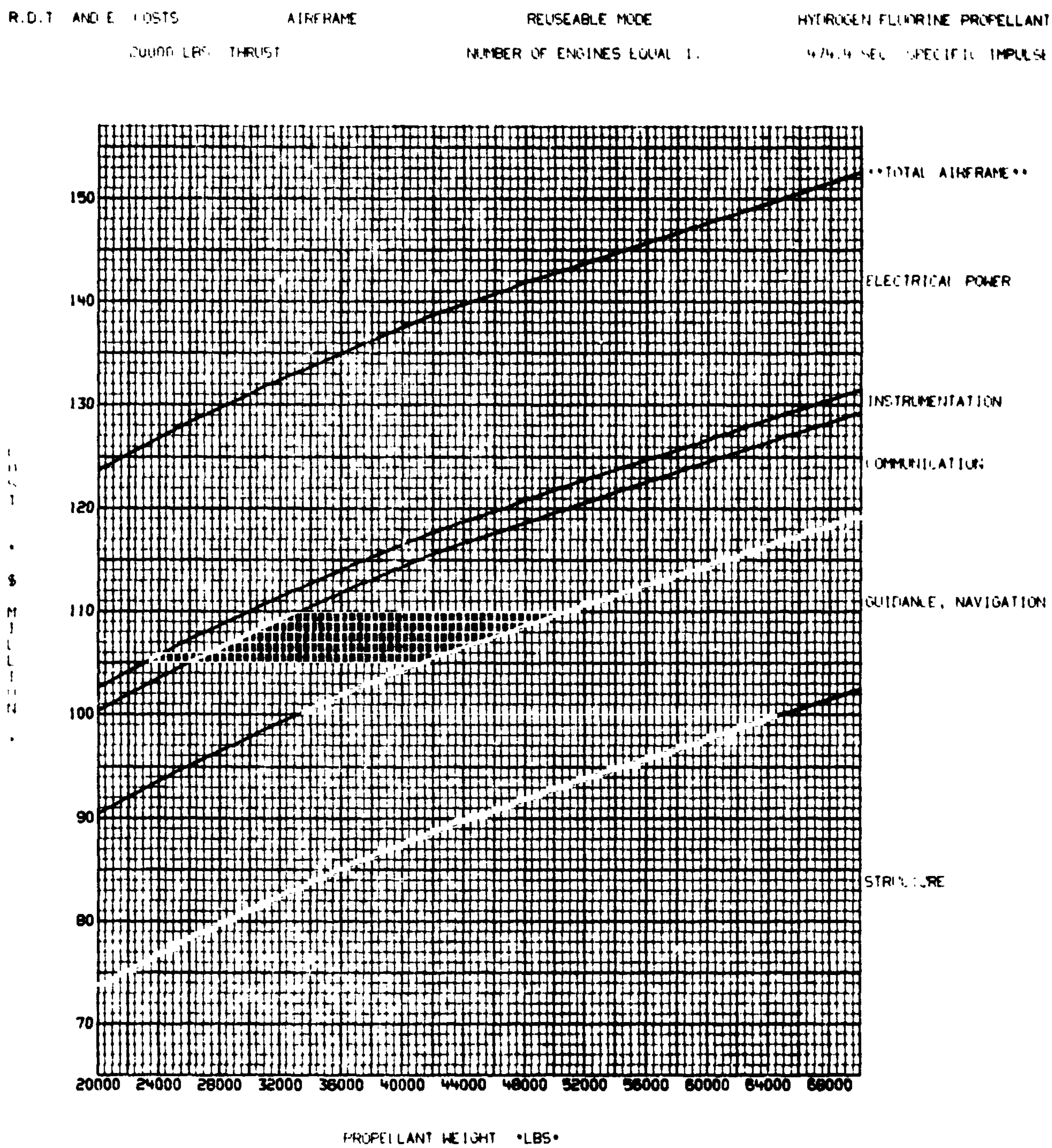

Figure 4-6. Parametric Avionics, Power and Structures RDT&E Costs, LF_2/LH_2 Single-Stage, Ground-Based Tugs

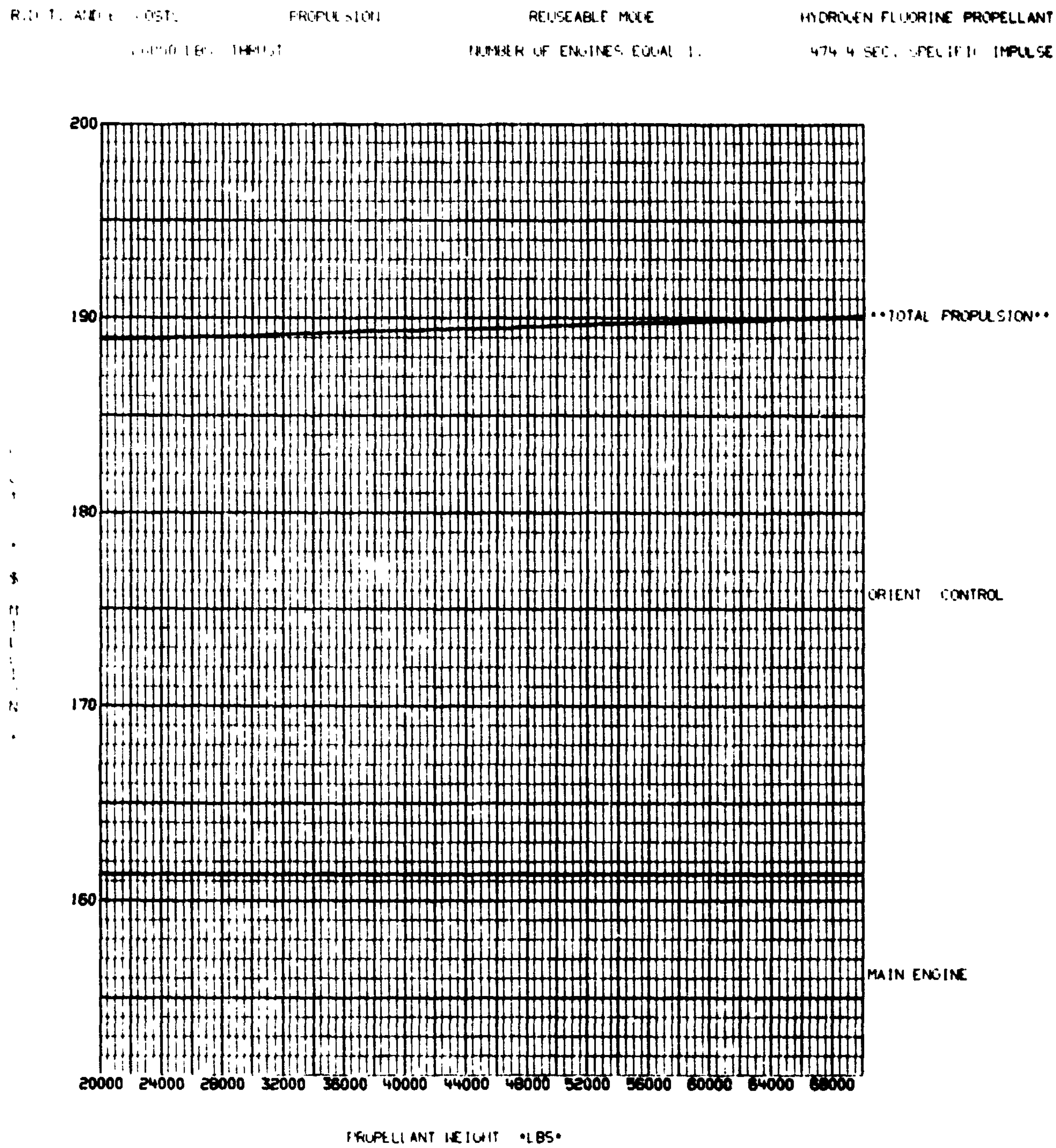

Figure 4-7. Parametric Propulsion RDT&E Costs, LF_2/LH_2 Single-Stage, Ground-Based Tugs

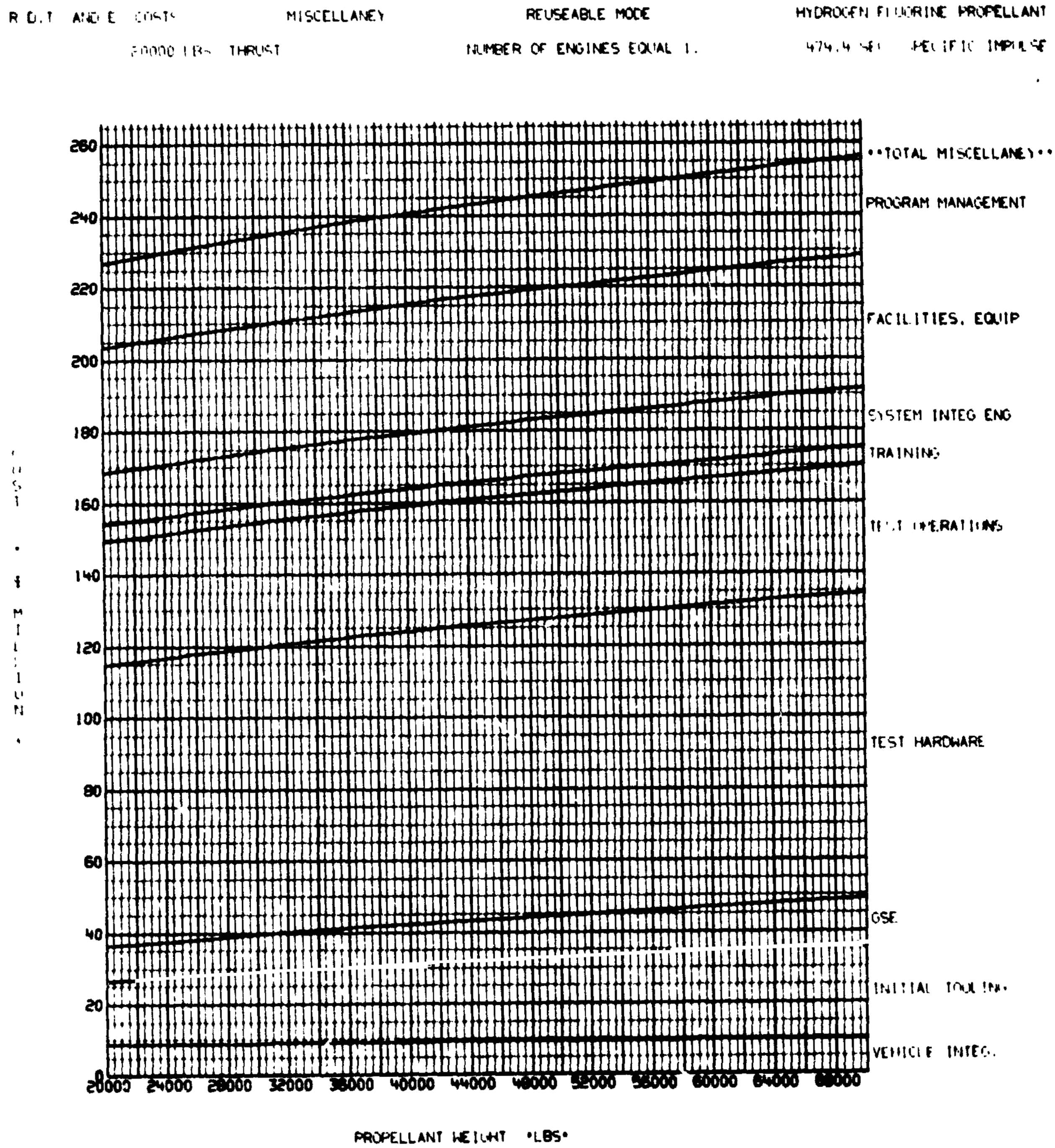

Figure 4-8. Parametric Floating-Item RDT&E Costs, LF_2/LH_2 Single-Stage, Ground-Based Tugs

Single-Stage FLOX/CH_4 Tug RDT&E Costs

This section presents RDT&E costs for single-stage, ground-based reusable Space Tugs that use FLOX/CH_4 propellants. A point estimate of RDT&E cost for the one reference FLOX/CH_4 Tug concept, sized at 52,000 lb propellant loading, is presented in Table 4-4.

Parametric RDT&E cost data for single-stage reusable FLOX/CH_4 Tugs are presented in Figures 4-9 through 4-12. These graphs follow the format and sequence used with the LO_2/LH_2 and LF_2/LH_2 Tug parametric data (i.e., total RDT&E costs first, followed by details of the major cost elements).

Table 4-4. RDT&E COST FOR FLOX/CH_4 SINGLE-STAGE, GROUND-BASED TUG (W_P = 52.0K)

Item	Cost ($ Millions)
Structure	64.204
Avionics	(28.998)
Guidance and Navigation	16.834
Communications	9.991
Instrumentation	2.173
Power Supply and Distribution	(21.010)
Electrical Power	21.010
Propulsion	(133.965)
Main Rocket Engine	105.876
Orientation Control	28.089
Initial Tooling	21.265
Ground Support Equipment	10.344
Test Hardware	72.918
Test Operations	33.983
Training	4.658
Systems Engineering and Integration	20.033
Program Management	22.233
Facilities	35.617
Total	469.728

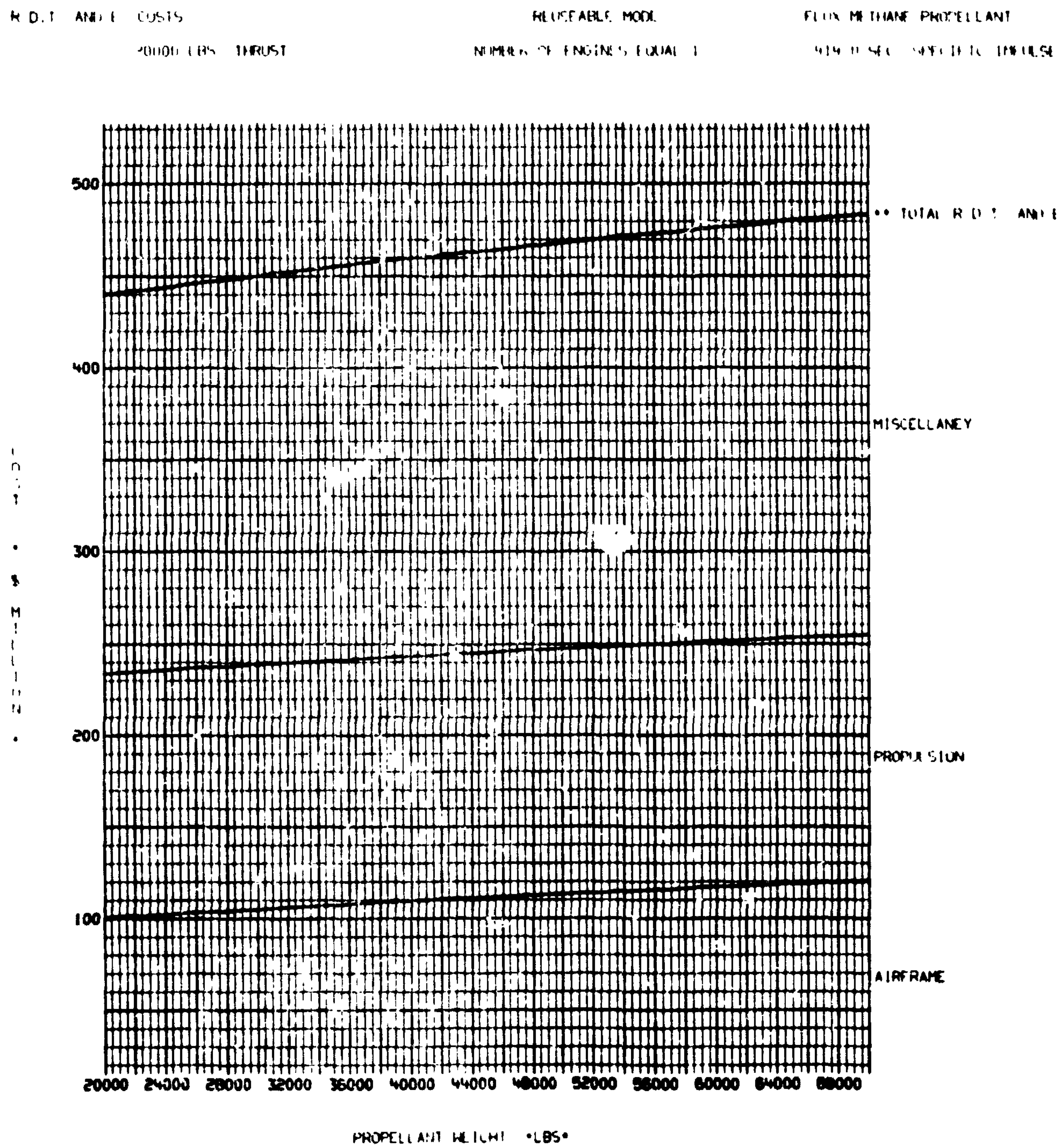

Figure 4-9. Parametric RDT&E Costs for FLOX/CH_4 Single-Stage, Ground-Based Tugs

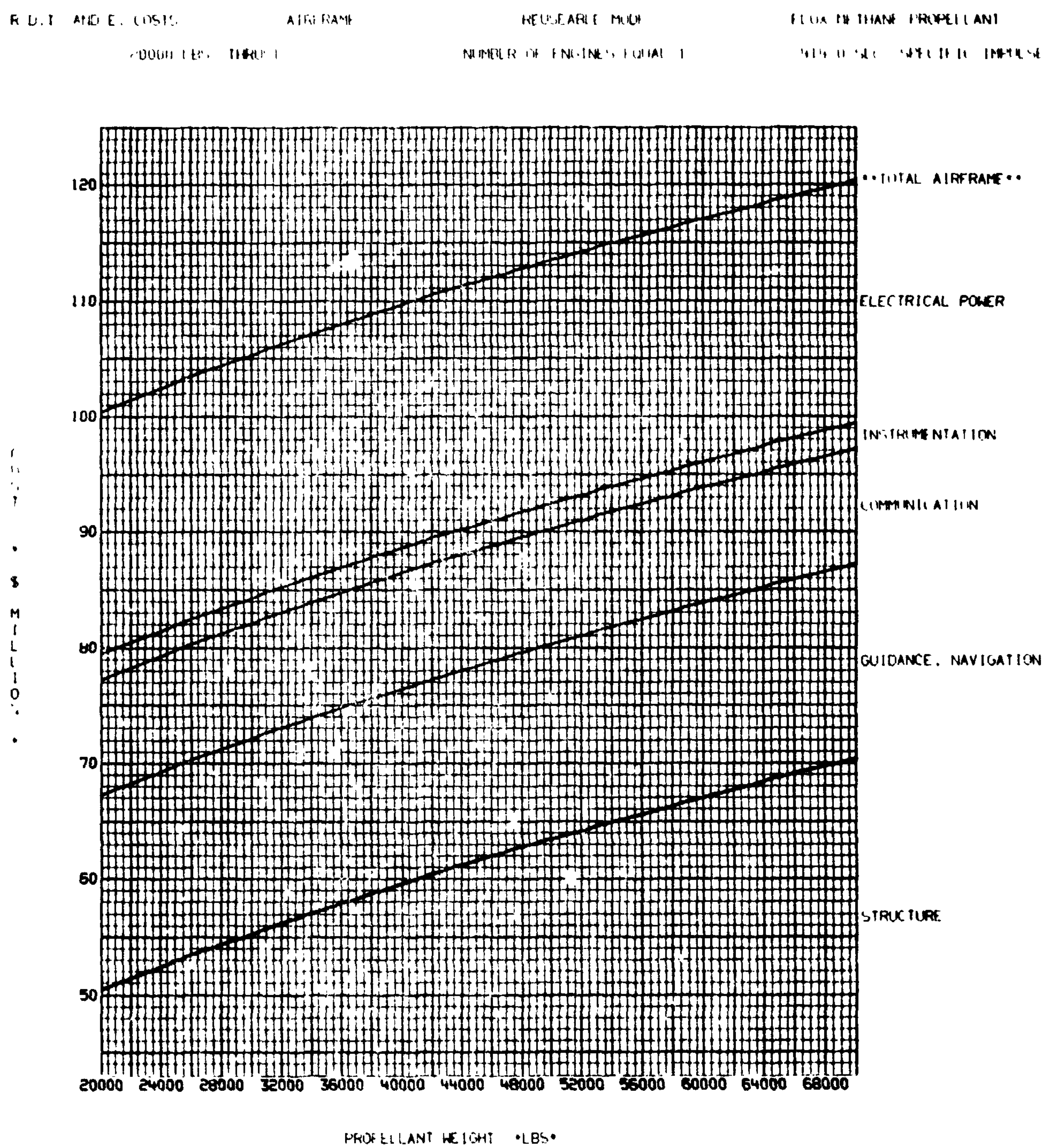

Figure 4-10. Parametric Avionics, Power and Structures RDT&E Costs, FLOX/CH_4 Single-Stage, Ground-Based Tugs

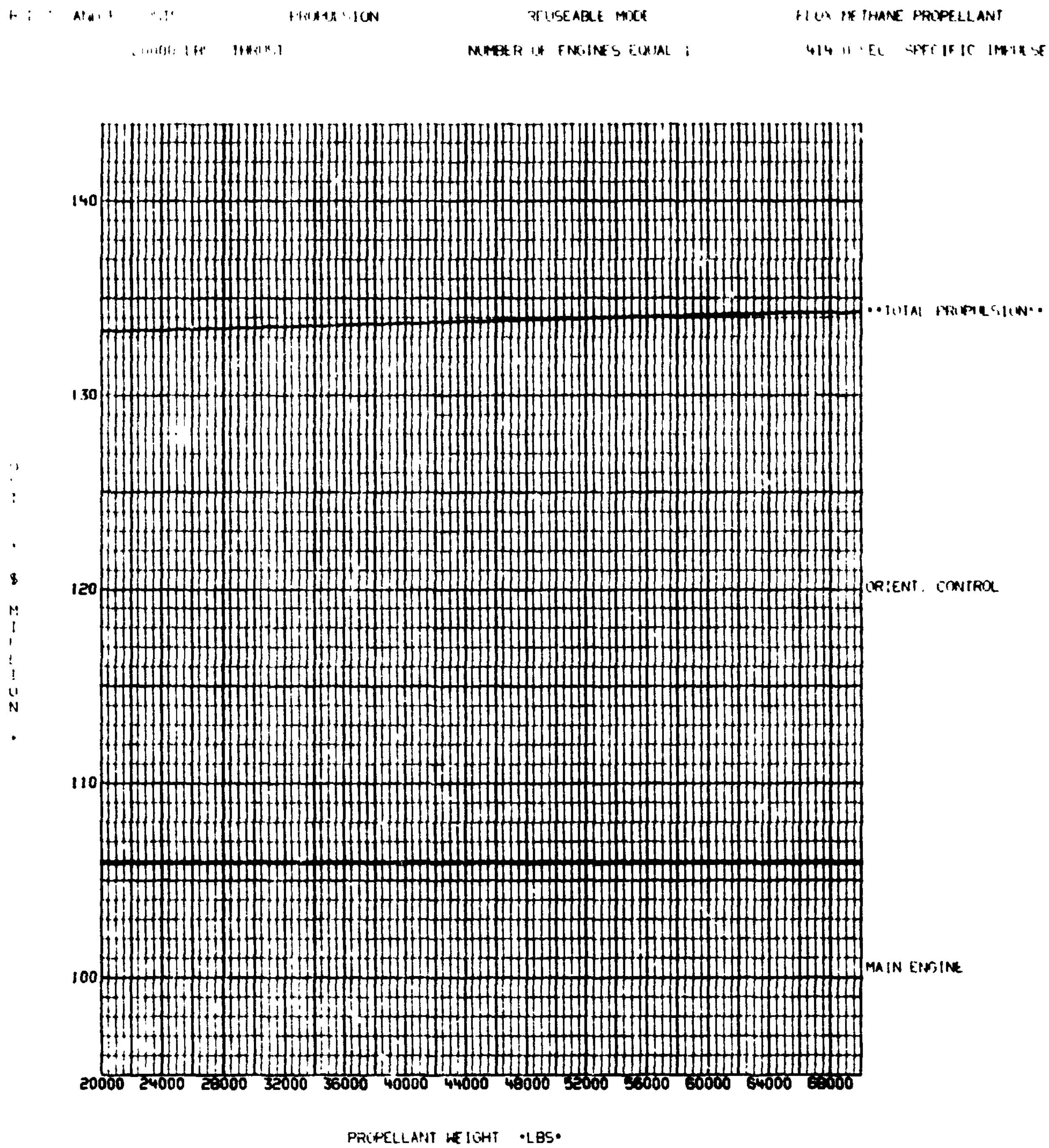

Figure 4-11. Parametric Propulsion RDT&E Costs, FLOX/CH_4 Single-Stage, Ground-Based Tugs

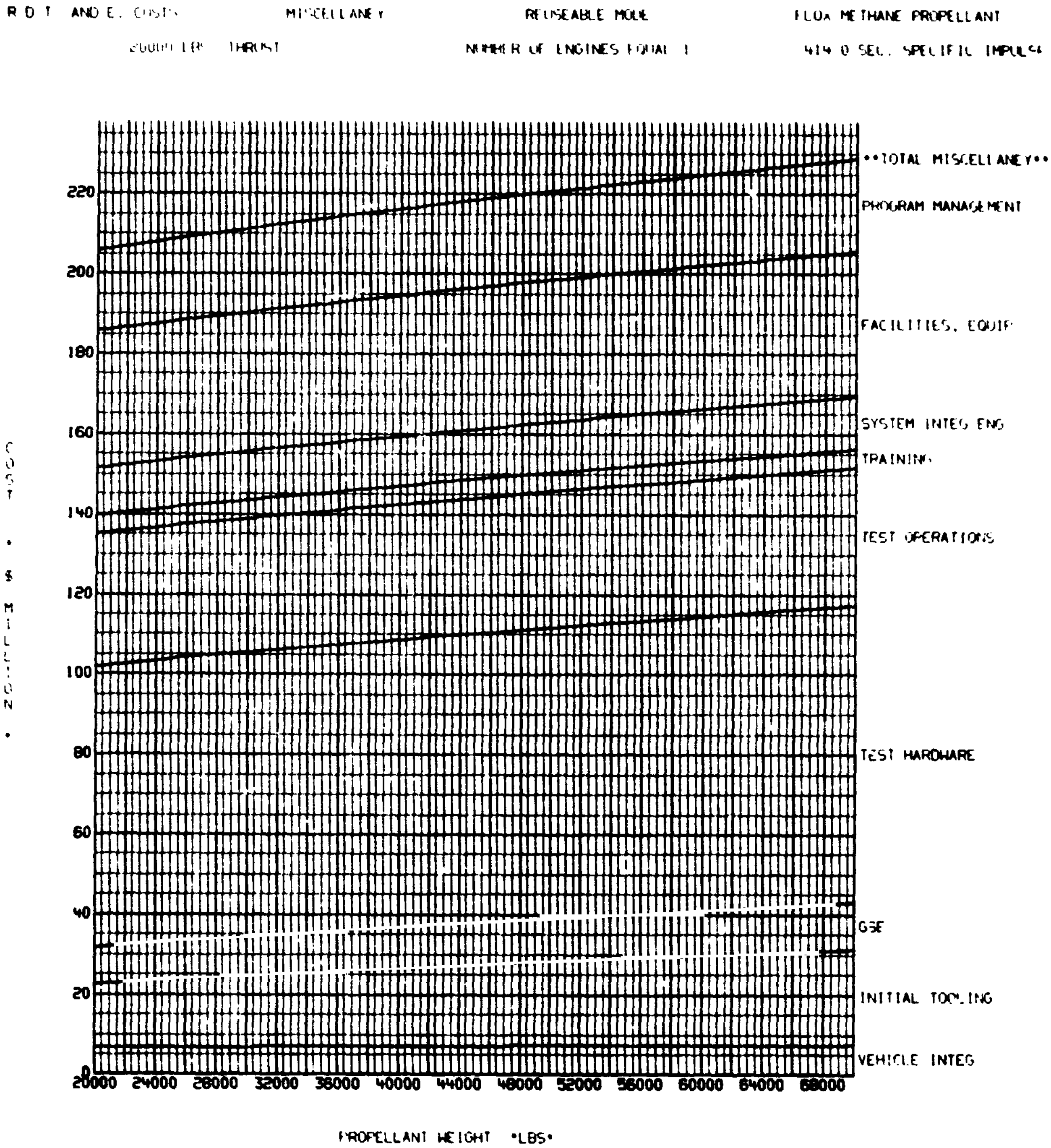

Figure 4-12. Parametric Floating-Item RDT&E Costs, FLOX/CH_4 Single-Stage, Ground-Based Tugs

Stage-And-One-Half LO_2/LH_2 Tug RDT&E Costs

This section presents RDT&E costs for ground-based Space Tugs using LO_2/LH_2 propellants. An RDT&E cost point-estimate for a reference stage-and-one-half LO_2/LH_2 Tug concept is presented in Table 4-5; this concept features a reusable core stage of 30,000 lb propellant loading and a set of expendable propellant tanks with total propellant capacity of 27,000 lb.

Parametric RDT&E cost data for the drop tanks, only, are presented in Figure 4-13. Applicable parametric RDT&E costs for the core stage are contained in Figure 4-1, previously referenced.

Table 4-5. RDT&E COST FOR LO_2/LH_2 STAGE-AND-ONE-HALF, GROUND-BASED TUG
(CORE W_P = 30K)

Item	Cost ($ Millions)
Structure	(121.903)
Core Stage	83.756
Drop Tanks	38.147
Avionics	(28.998)
Guidance and Navigation	16.834
Communications	9.991
Instrumentation	2.173
Power Supply and Distribution	(21.010)
Electrical Power	21.010
Propulsion	(133.741)
Main Rocket Engine	105.876
Orientation Control	27.865
Initial Tooling	22.388
Ground Support Equipment	11.236
Test Hardware	80.470
Test Operations	36.798
Training	4.809
Systems Engineering and Integration	25.661
Program Management	28.262
Facilities	35.931
Total	551.207

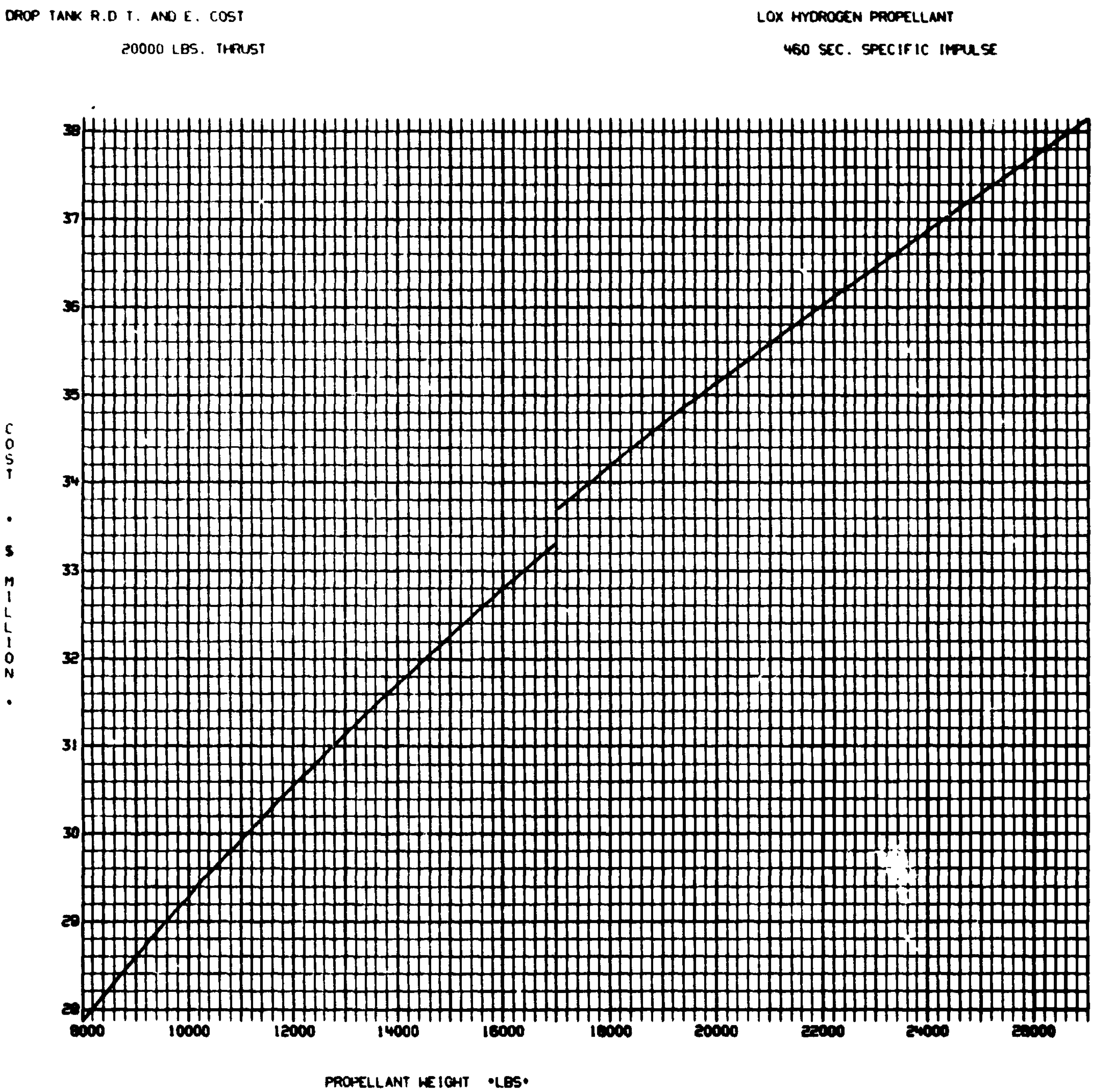

Figure 4-13. Parametric RDT&E Costs for LO_2/LH_2 Drop Tanks

INVESTMENT COSTS

INVESTMENT COSTS

The costs associated with the Investment phase of the Space Tug program are reported in this section. This investment phase, which overlaps the RDT&E phase, includes the acquisition of vehicles, facilities, and equipment needed to support an operational Space Tug system. Costs specifically included in this phase comprise recurring-production expenditures for the acquisition of the reusable Tug fleet and spares; the expendable Tugs, drop tanks, and their spares; and the facilities, tooling, and GSE above and beyond RDT&E phase requirements. These costs also include management and support services incurred during the Investment phase.

The Investment phase cost data present the breakdown of total Investment costs (as point values and parametric data) as well as theoretical first-unit costs. The term theoretical first unit denotes that such values are of use primarily in costing multiple-unit vehicle buys and have little value as anticipated unit cost estimates. Learning curve factors used in calculating Investment phase costs were as follows:

- Tug core vehicles - 95 percent
- Expendable drop tanks - 88 percent

For definition of the individual WBS entries used in the first-unit cost data, refer to Chapter 2.

LO_2/LH_2 Single-Stage Tug Investment Costs

Point cost data for Investment phase expenditures in LO_2/LH_2 reusable ground-based Tugs are presented in Tables 4-6 through 4-9. These costs are for single-stage Tugs sized at 36,300 lb and 50,200 lb propellant loading. Tables 4-6 and 4-7 present theoretical first-unit costs for the two Tug sizes, while Tables 4-8 and 4-9 present the total Investment phase costs for the two point designs.

Parametric Investment cost data for the spectrum of potential LO_2/LH_2 single-stage Tugs are presented in Figures 4-14 through 4-17. Figures 4-14 and 4-15 present curves of parametric first-unit costs for reusable and expendable versions, respectively, of the basic LO_2/LH_2 Tug concept. Note that the effect of omitting hardware for retrieval and reuse is to reduce the first-unit cost of the expendable version by more than 50 percent. Figures 4-16 and 4-17 contain parametric data on the total Investment costs for reusable and expendable versions of this Tug.

Table 4-6. FIRST-UNIT COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 36.3K)

Item	Cost ($ millions)
Structure (Including Insulation and Propellant Feed)	(3.168)
Core Stage	3.168
Drop Tank	0.000
Avionics	(8.419)
Guidance and Navigation	5.524
Communications	1.995
Instrumentation	0.900
Power Supply and Distribution	(2.371)
Electrical Power	2.371
Propulsion	(1.338)
Main Rocket Engine	0.406
Orientation Control	0.932
Integration, Assembly, Checkout and Test	0.714
Total	16.010

Table 4-7. FIRST-UNIT COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 50.2K)

Item	Cost ($ millions)
Structure (Including Insulation and Propellant Feed)	(3.470)
Core Stage	3.470
Drop Tanks	0.000
Avionics	(8.419)
Guidance and Navigation	5.524
Communications	1.995
Instrumentation	0.900
Power Supply and Distribution	(2.371)
Electrical Power	2.371
Propulsion	(1.351)
Main Rocket Engine	0.406
Orientation Control	0.945
Integration, Assembly, Checkout and Test	0.778
Total	16.389

Table 4-8. INVESTMENT COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 36.3K)

Item	Cost ($ millions)
Reusable Fleet Cost (14 Tugs Plus Initial Spares and Support)	235.044
Expendable Hardware Cost	(468.903)
Expendable Tugs (64 Units Plus Spares/Support)	468.903
Drop Tanks (0 Sets)	0.000
Facilities and Equipment	22.458
Total	726.405

Table 4-9. INVESTMENT COST FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 50.2K)

Item	Cost ($ millions)
Reusable Fleet Cost (17 Tugs Plus Initial Spares and Support)	312.275
Expendable Hardware Cost	(116.793)
Expendable Tugs (14 Units Plus Spares/Support)	116.793
Drop Tanks (0 Sets)	0.000
Facilities and Equipment	23.896
Total	452.964

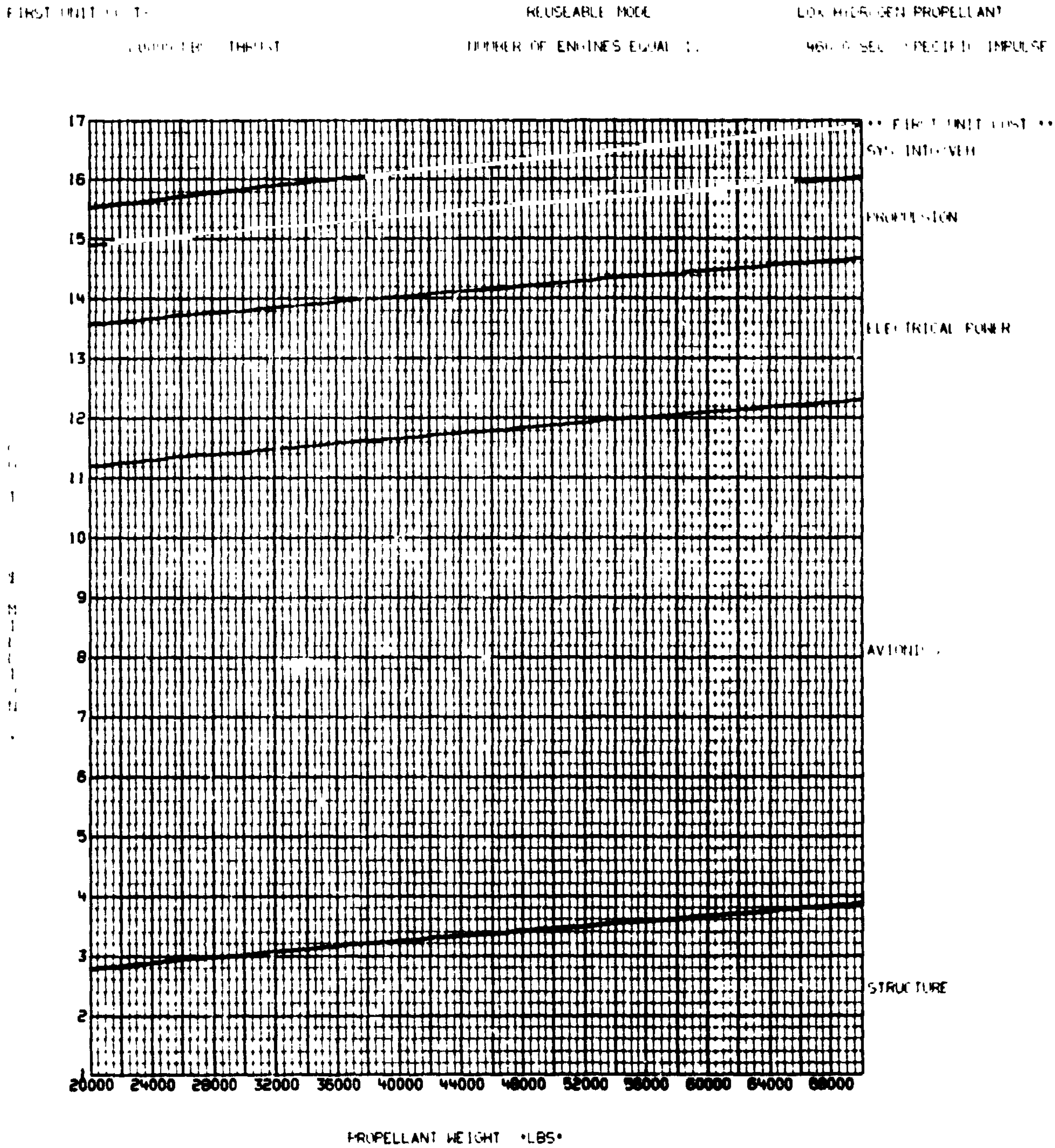

Figure 4-14. Parametric First-Unit Costs for Reusable Versions of LO_2/LH_2 Single-Stage Tugs

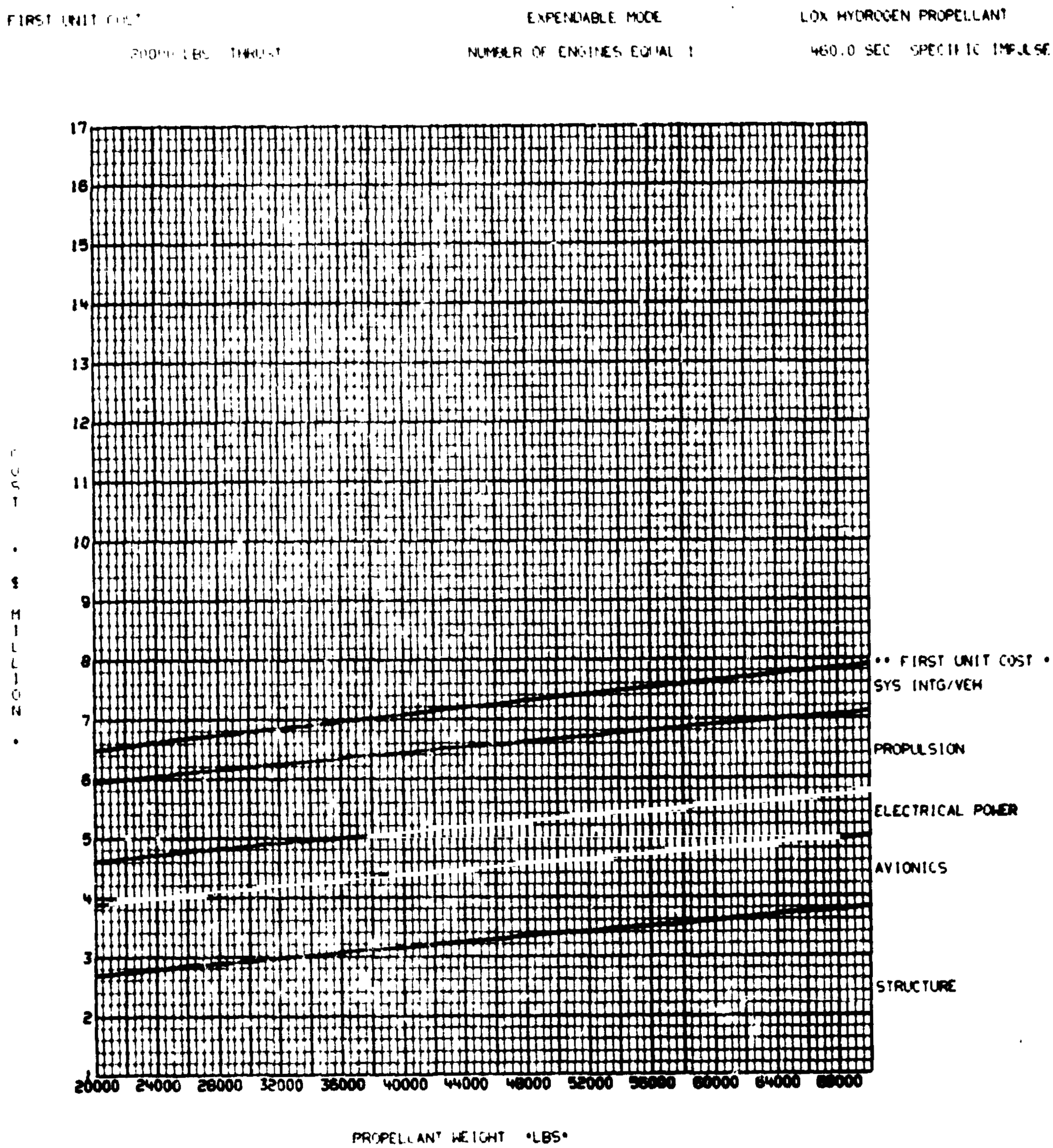

Figure 4-15. Parametric First-Unit Costs for Expendable Versions of LO_2/LH_2 Single-Stage Tugs

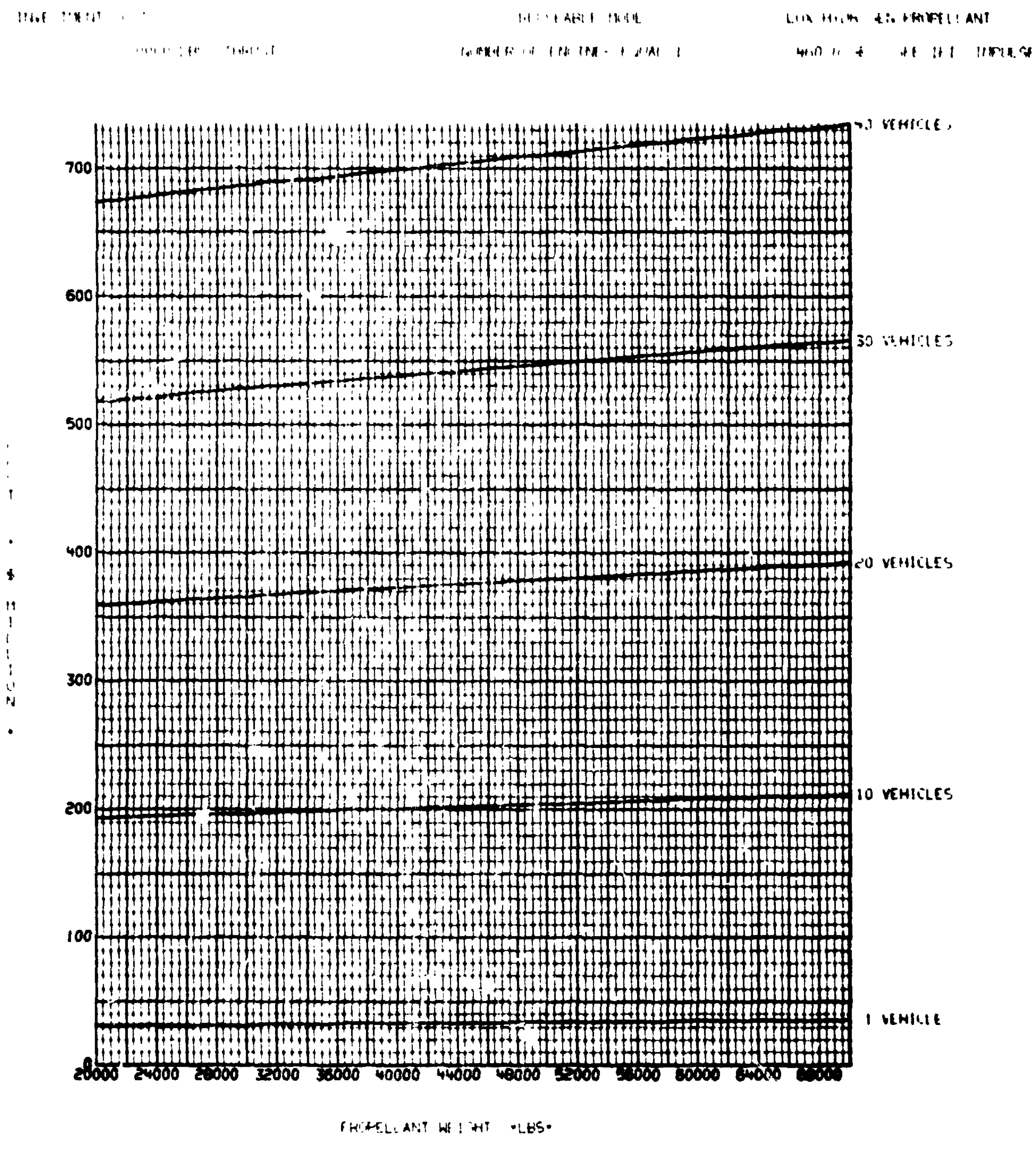

Figure 4-16. Parametric Investment Costs for Reusable Versions of LO_2/LH_2 Single-Stage Tugs

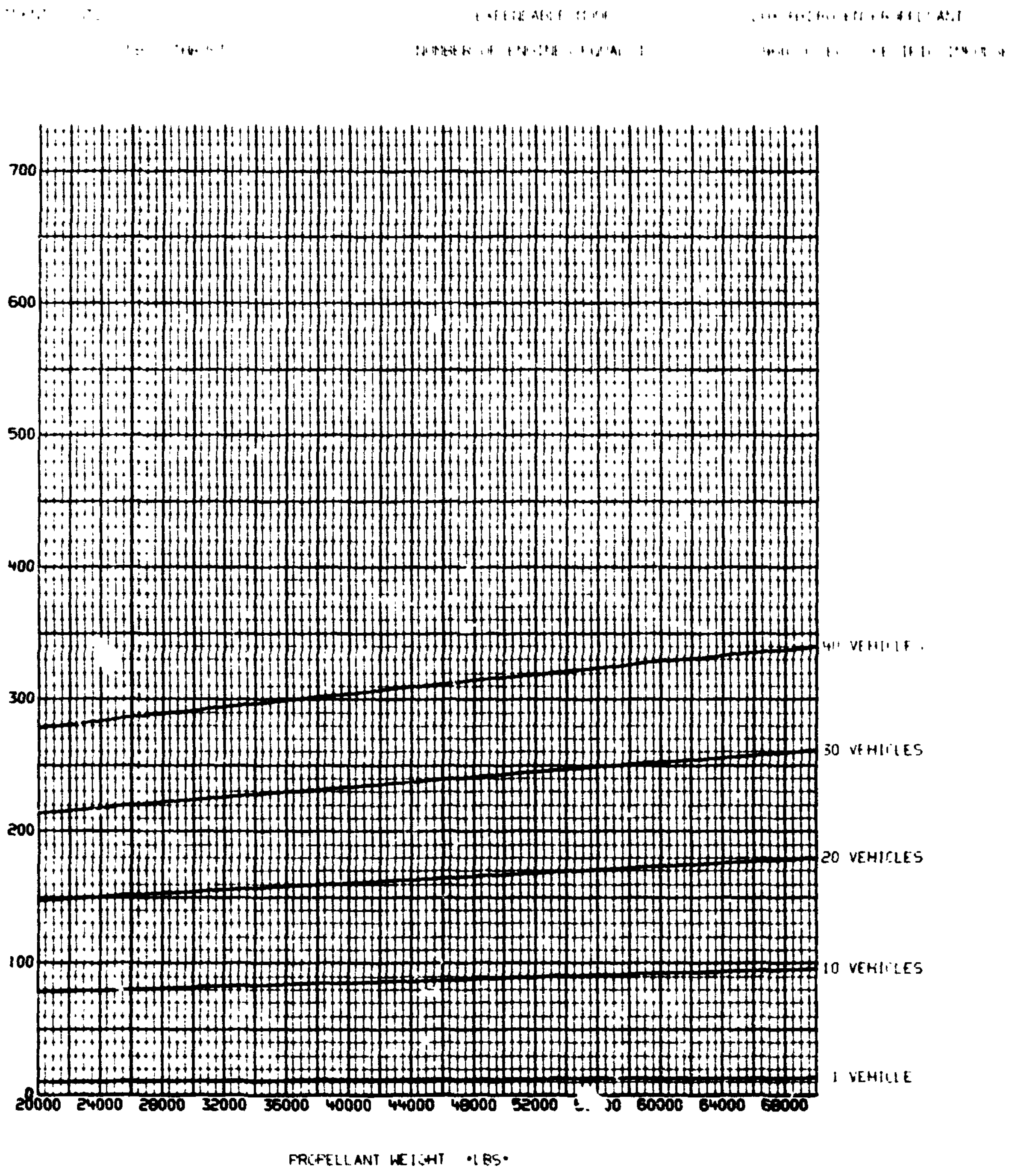

Figure 4-17. Parametric Investment Costs for Expendable Versions of LO_2/LH_2 Single-Stage Tugs

LF_2/LH_2 Single-Stage Tug Investment Costs

Point investment-cost data for an LF_2/LH_2 reusable ground-based Tug sized at 47,800 lb propellant loading are presented in Tables 4-10 and 4-11. Table 4-10 contains the theoretical first-unit costs for this Tug while Table 4-11 presents the total Investment phase expenditure requirements.

Parametric data on the Investment phase costs of single-stage LF_2/LH_2 Tugs are presented in Figures 4-18 through 4-21. Curves of first-unit costs for reusable and expendable versions of the LF_2/LH_2 Tug are given in Figures 4-18 and 4-19, respectively; total Investment costs for these same two versions are graphed in Figures 4-20 and 4-21.

Table 4-10. FIRST-UNIT COST FOR LF_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 47.8K)

Item	Cost ($ millions)
Structure (Including Insulation and Propellant Feed)	(3.498)
Core Stage	3.498
Drop Tank	0.000
Avionics	(8.419)
Guidance and Navigation	5.524
Communications	1.995
Instrumentation	0.900
Power Supply and Distribution	(2.371)
Electrical Power	2.371
Propulsion	(1.432)
Main Rocket Engine	0.487
Orientation Control	0.945
Integration, Assembly, Checkout and Test	0.847
Total	16.567

Table 4-11. INVESTMENT COST FOR LF_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG (W_P = 47.8K)

Item	Cost ($ millions)
Reusable Fleet Cost (17 Tugs Plus Initial Spares and Support)	327.977
Expendable Hardware Cost	(17.812)
Expendable Tugs (2 Units Plus Spares/Support)	17.812
Drop Tanks (0 Sets)	0.000
Facilities and Equipment	22.272
Total	368.061

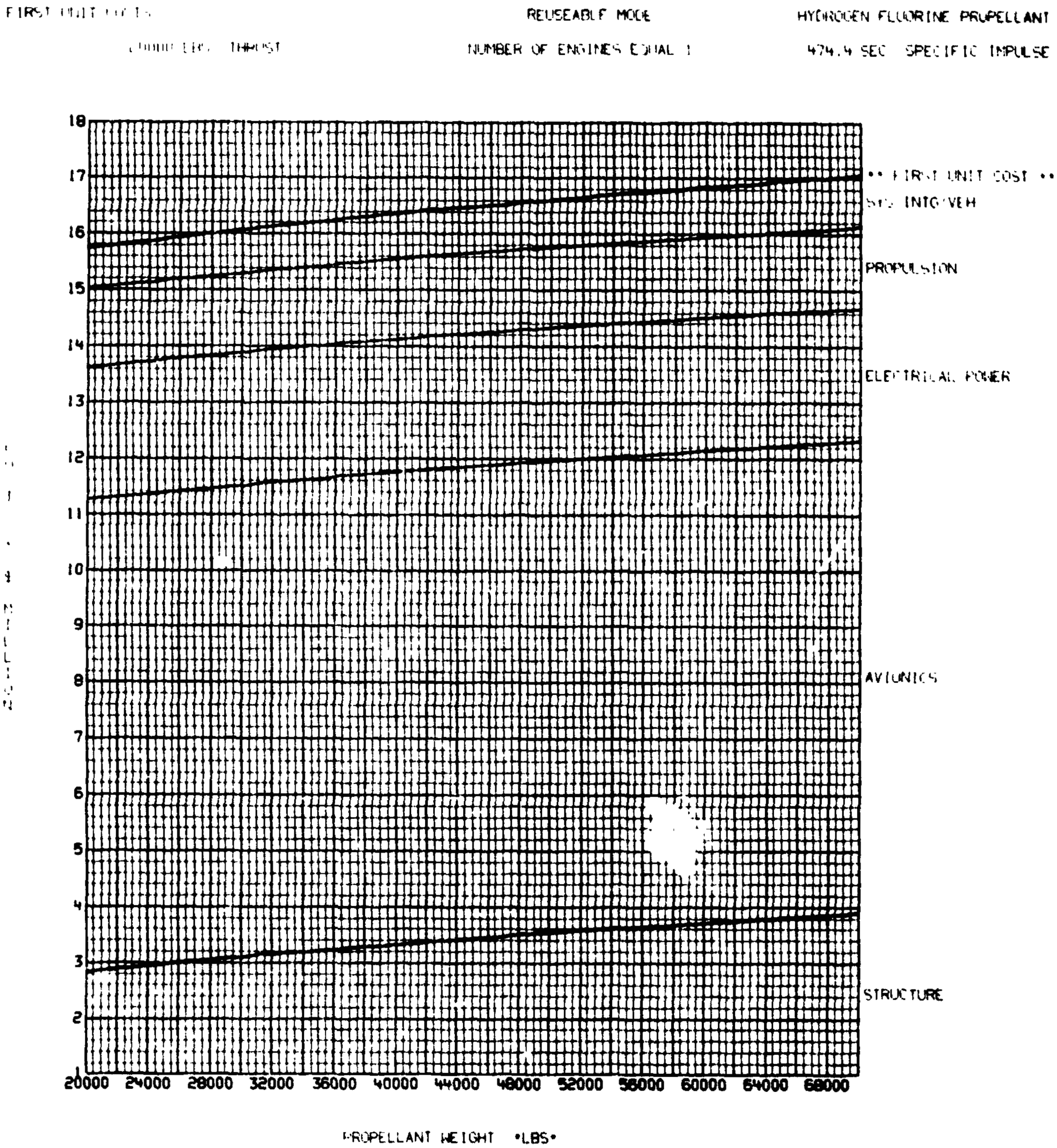

Figure 4-18. Parametric First-Unit Costs for Reusable Versions of LF_2/LH_2 Single-Stage Tugs

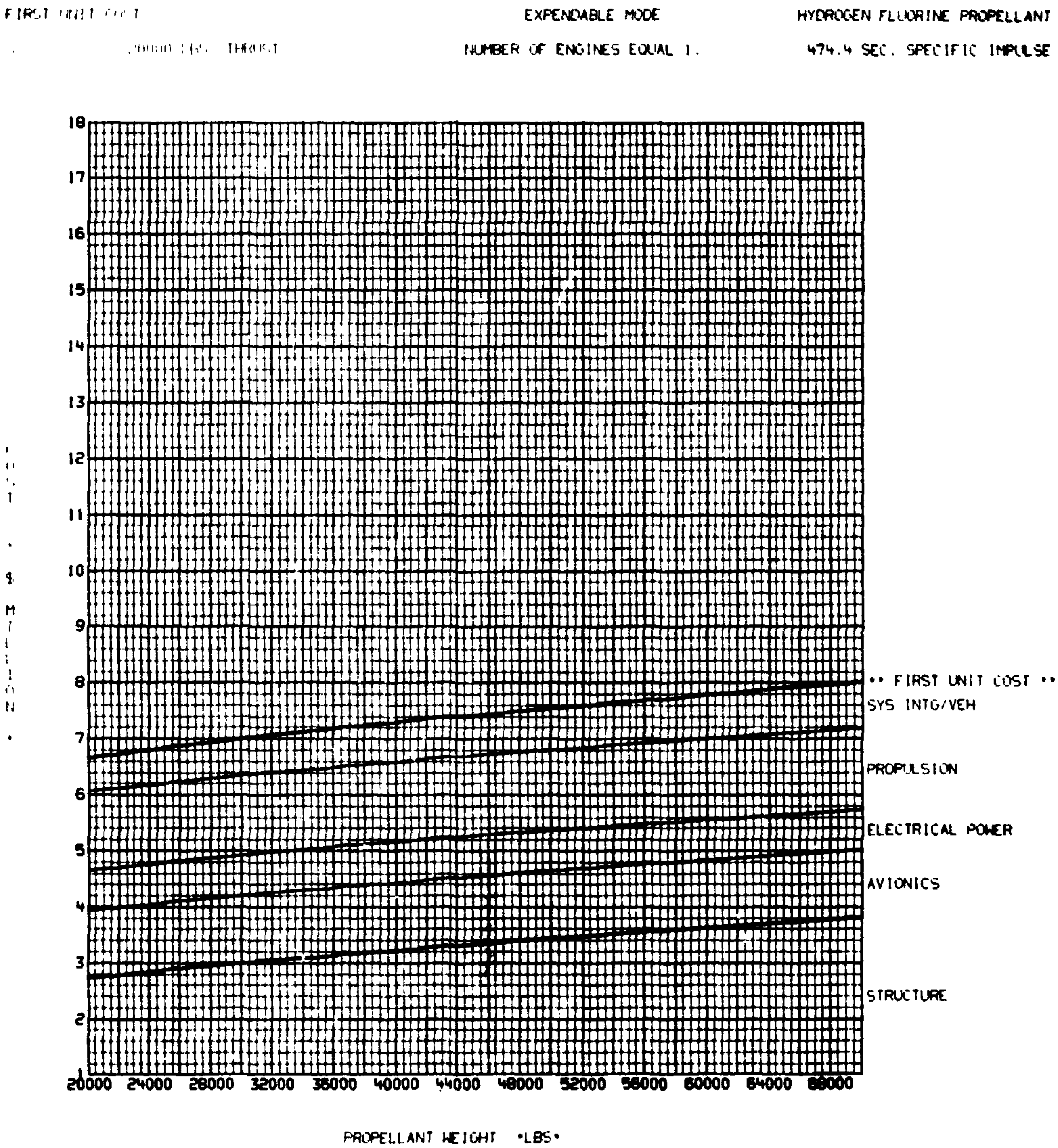

Figure 4-19. Parametric First-Unit Costs for Expendable Versions of LF_2/LH_2 Single-Stage Tugs

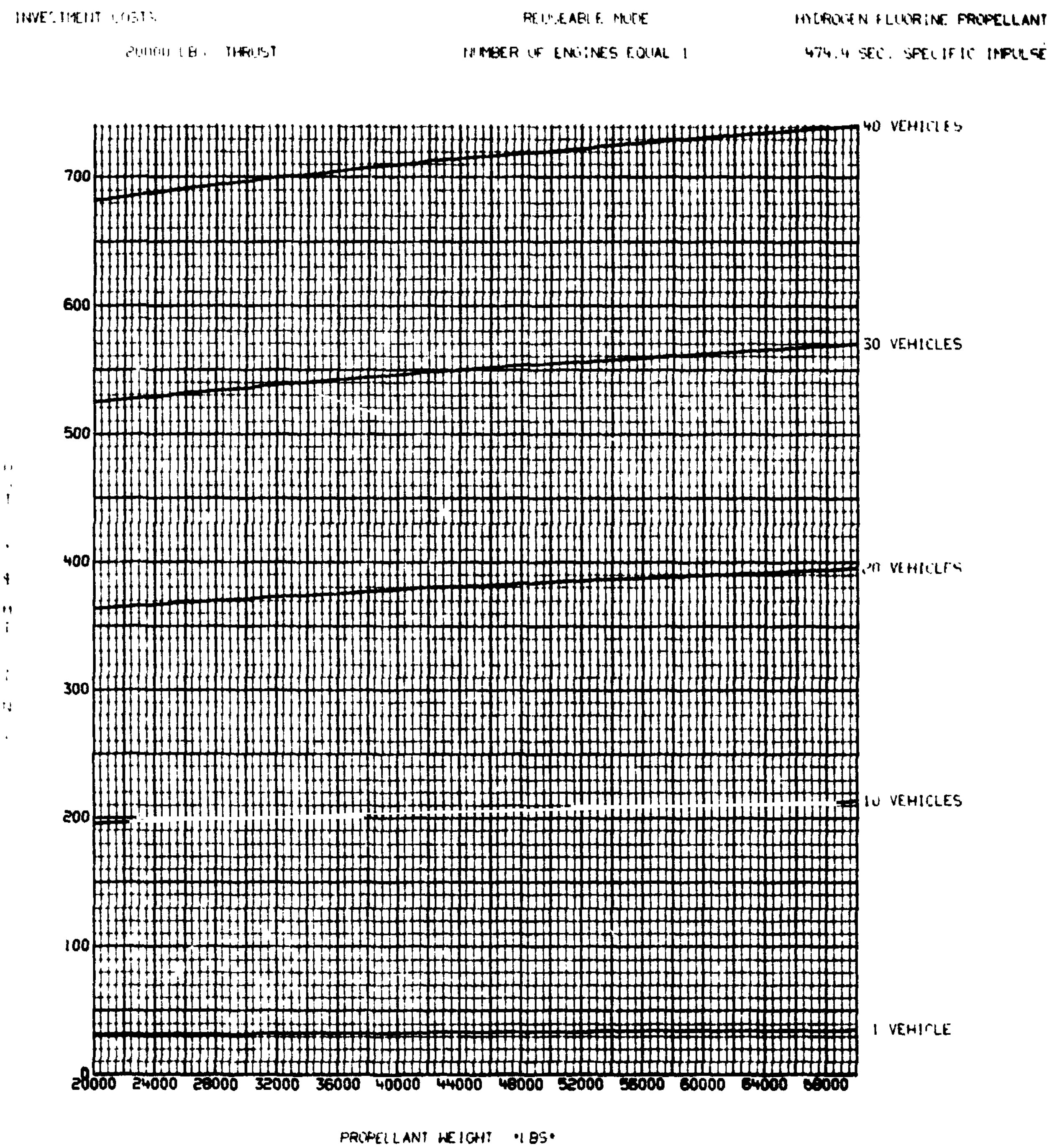

Figure 4-20. Parametric Investment Costs for Reusable Versions of LF_2/LH_2 Single-Stage Tugs

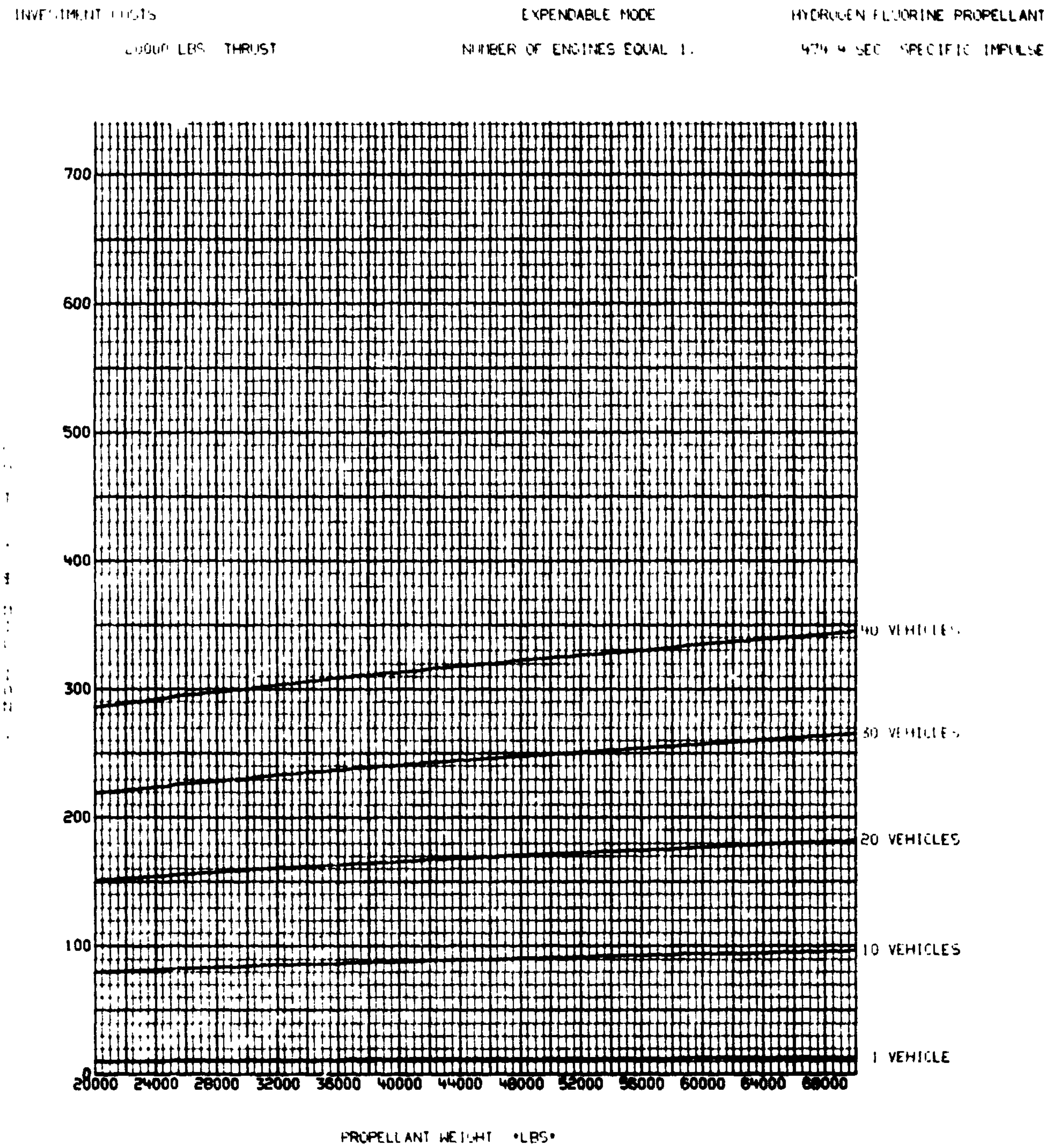

Figure 4-21. Parametric Investment Costs for Expendable Versions of LF_2/LH_2 Single-Stage Tugs

FLOX/CH_4 Single-Stage Tug Investment Costs

Point Investment-cost data for a FLOX/CH_4 reusable ground-based tug sized at 52,000 lb propellant loading are presented in Tables 4-12 and 4-13. Table 4-12 contains the theoretical first-unit costs for this Tug while Table 4-13 presents the total Investment phase expenditure requirements.

Parametric data on the Investment phase costs for single-stage FLOX/CH_4 Tugs are presented in Figures 4-22 through 4-25. Curves of first-unit costs for reusable and expendable versions of the FLOX/CH_4 Tug are given in Figures 4-22 and 4-23, respectively; the total Investment costs for these same two versions are graphed in Figures 4-24 and 4-25.

Table 4-12. FIRST-UNIT COST FOR FLOX/CH_4 SINGLE-STAGE, GROUND-BASED TUG

(W_P = 52.0K)

Item	Cost ($ millions)
Structure (Including Insulation and Propellant Feed)	(1.694)
Core Stage	1.694
Drop Tank	0.000
Avionics	(8.419)
Guidance and Navigation	5.524
Communications	1.995
Instrumentation	0.900
Power Supply and Distribution	(2.371)
Electrical Power	2.371
Propulsion	(1.373)
Main Rocket Engine	0.433
Orientation Control	0.940
Integration, Assembly, Checkout and Test	0.727
Total	14.584

Table 4-13. INVESTMENT COST FOR FLOX/CH_4 SINGLE-STAGE, GROUND-BASED TUG

(W_P = 52.0K)

Item	Cost ($ million)
Reusable Fleet Cost (17 Tugs Plus Initial Spares and Support)	281.596
Expendable Hardware Cost	(58.085)
Expendable Tugs (9 Units Plus Spares/Support)	58.085
Drop Tanks (0 Sets)	0.000
Facilities and Equipment	21.257
Total	360.938

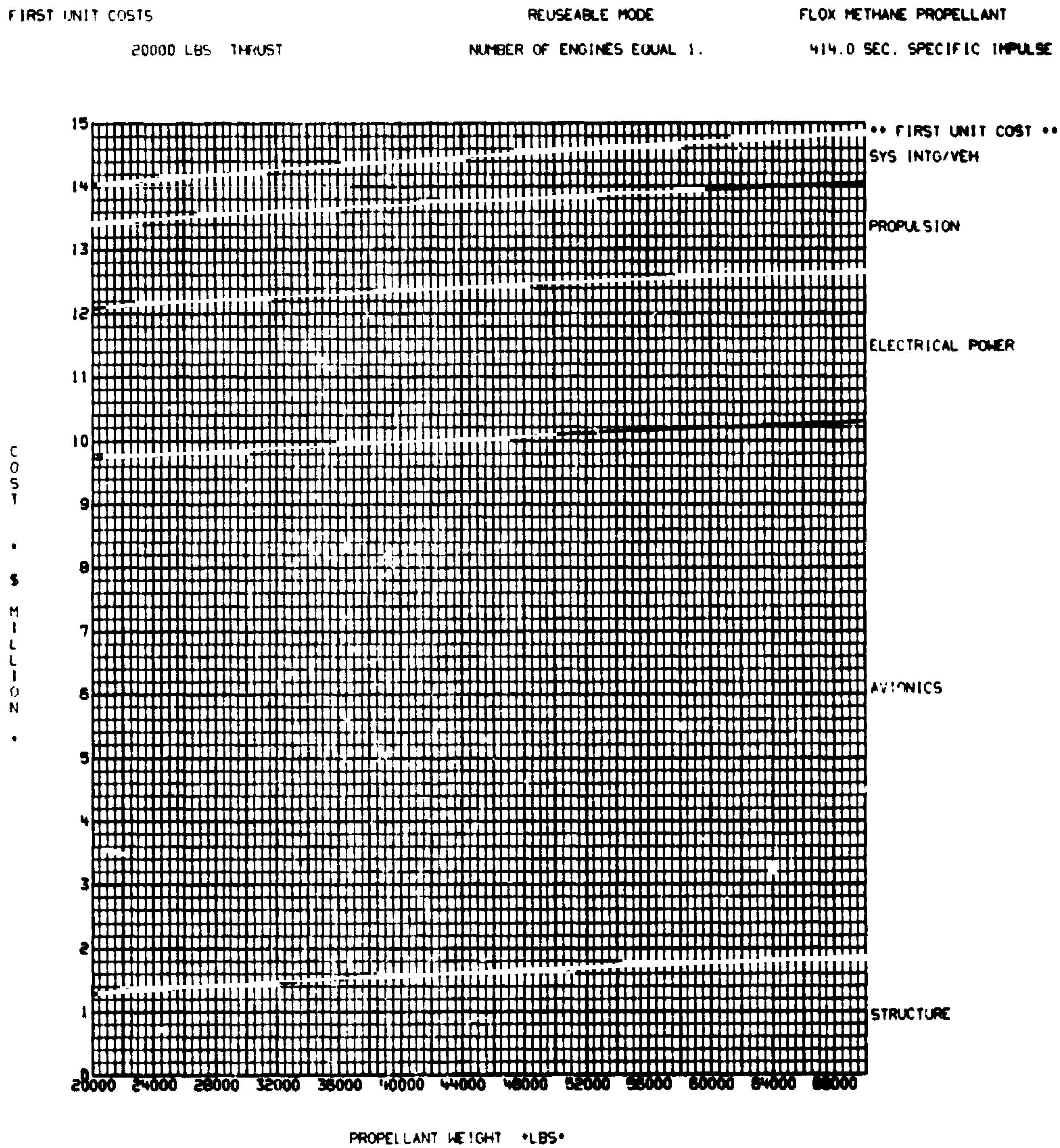

Figure 4-22. Parametric First-Unit Costs for Reusable Versions of $FLOX/CH_4$ Single-Stage Tugs

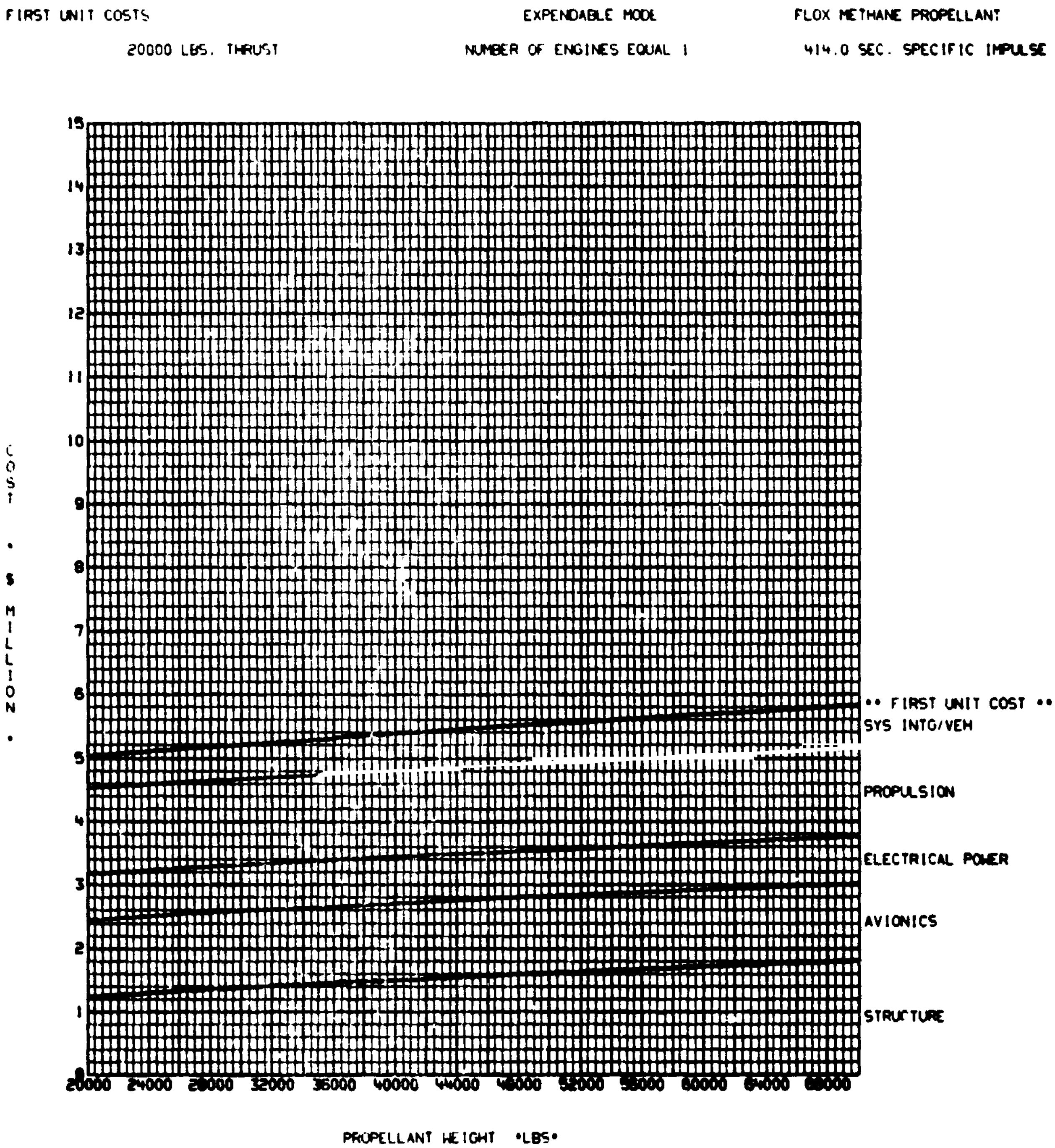

Figure 4-23. Parametric First-Unit Costs for Expendable Versions of FLOX/CH_4 Single-Stage Tugs

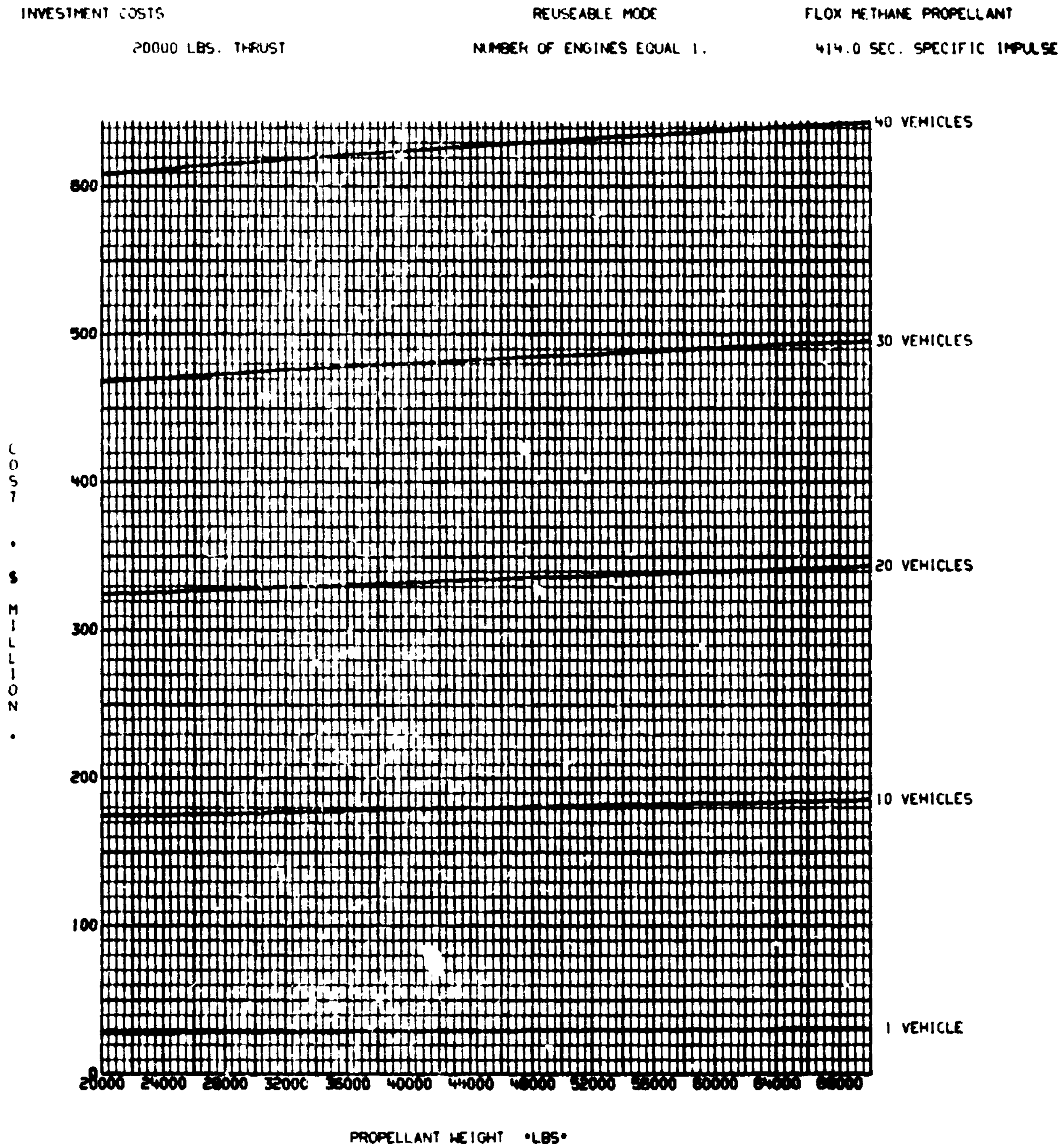

Figure 4-24. Parametric Investment Costs for Reusable Versions of FLOX/CH_4 Single-Stage Tugs

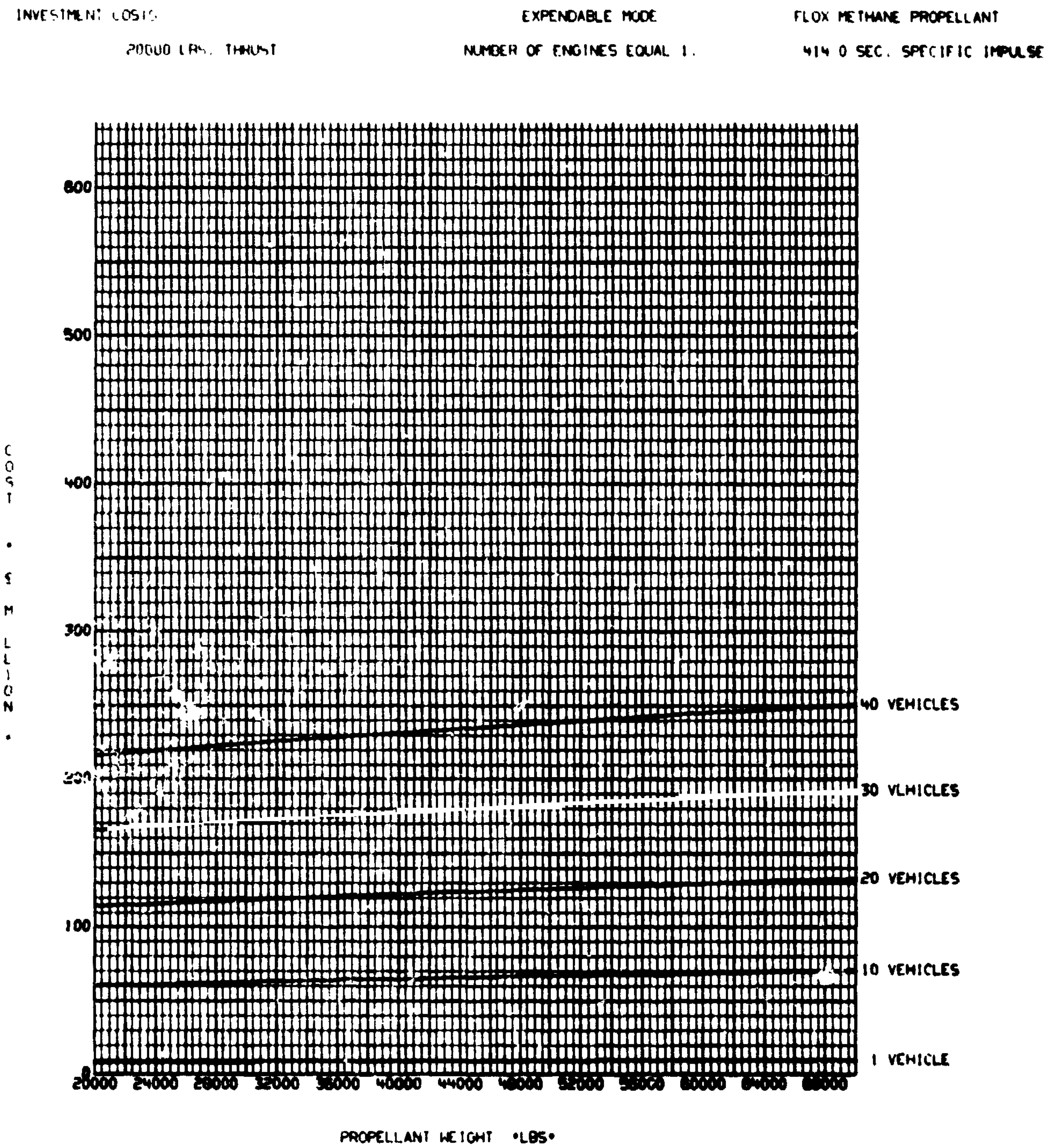

Figure 4-25. Parametric Investment Costs for Expendable Versions of FLOX/CH_4 Single-Stage Tugs

LO_2/LH_2 Stage-and-One-Half Tug Investment Costs

The point cost data on Investment phase expenditure requirements for an LO_2/LH_2 stage-and-one-half Tug sized at 30,000 lb core-stage and 27,000 lb drop-tank propellant weights are presented in Tables 4-14 and 4-15. Table 4-14 contains the theoretical first-unit costs for this Tug while Table 4-15 presents the total Investment phase expenditure requirements.

Parametric data on the Investment phase costs of the expendable LO_2/LH_2 drop-tank set are plotted in Figures 4-26 and 4-27. Figure 4-26 graphs the first-unit costs over a range of sizes from 8000 lb to 26,000 lb propellant; Figure 4-27 presents the curves of total Investment cost over the same size range.

Table 4-14. FIRST-UNIT COST FOR LO_2/LH_2 STAGE-AND-ONE HALF, GROUND-BASED TUG (CORE W_P = 30K)

Item	Cost ($ Millions)
Structure (Including Insulation and Propellant Feed)	(3.283)
Core Stage	3.048
Drop Tank	0.235
Avionics	(8.419)
Guidance and Navigation	5.524
Communications	1.995
Instrumentation	0.900
Power Supply and Distribution	(2.371)
Electrical Power	2.371
Propulsion	(1.337)
Main Rocket Engine	0.406
Orientation Control	0.931
Integration, Assembly, Checkout and Test	0.686
Total	16.096

Table 4-15. INVESTMENT COST FOR LO_2/LH_2 STAGE-AND-ONE-HALF, GROUND-BASED TUG (CORE W_P = 30K)

Item	Cost ($ Millions)
Reusable Fleet Cost (16 Tugs Plus Initial Spares and Support)	298.642
Expendable Hardware Cost	(37.151)
Expendable Tugs (1 Unit Plus Spares/Support)	8.189
Drop Tanks (236 Sets Plus Spares/Support)	23.962
Facilities and Equipment	21.821
Total	357.614

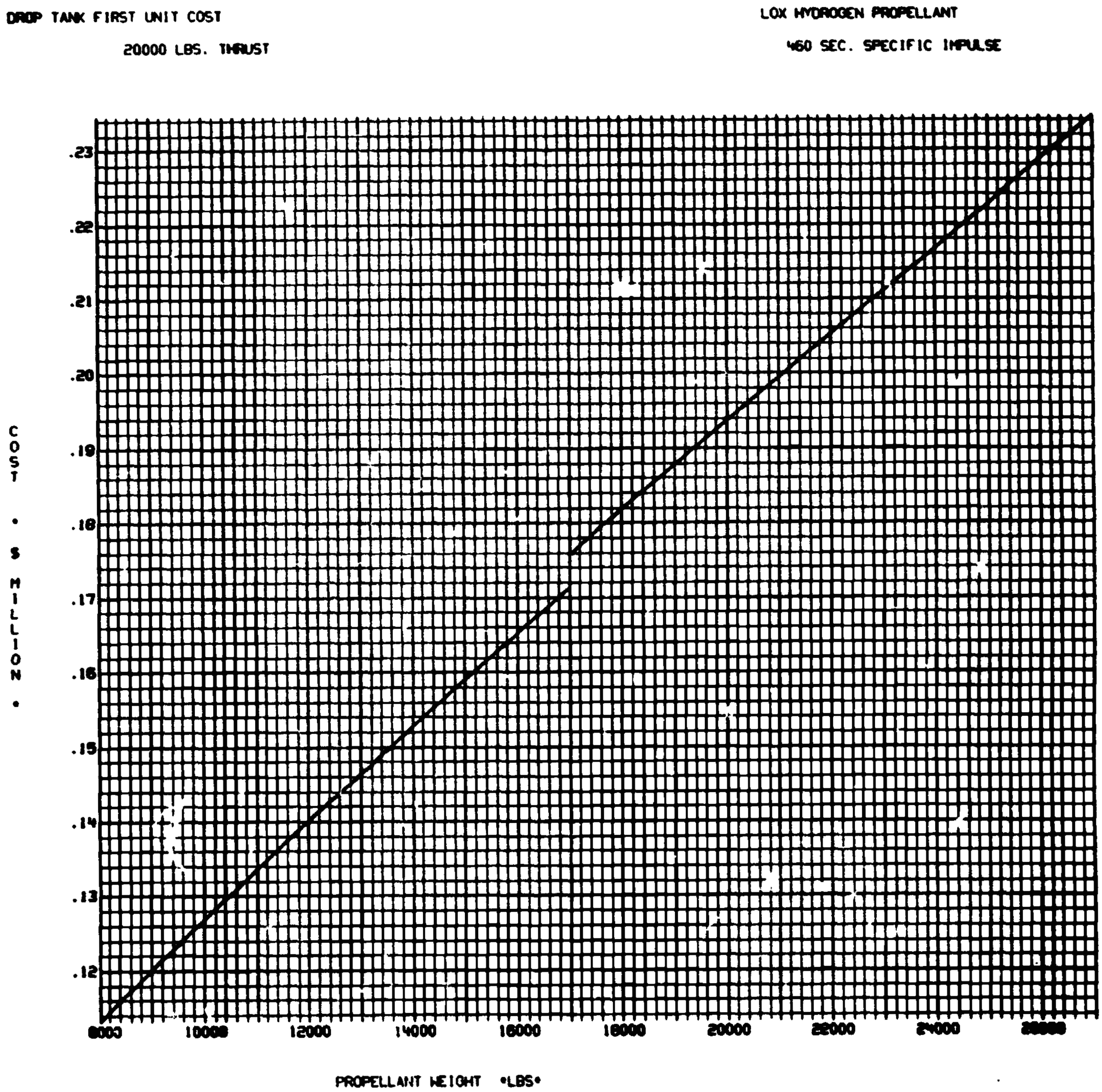

Figure 4-26. Parametric First-Unit Cost for LO_2/LH_2 Drop Tanks

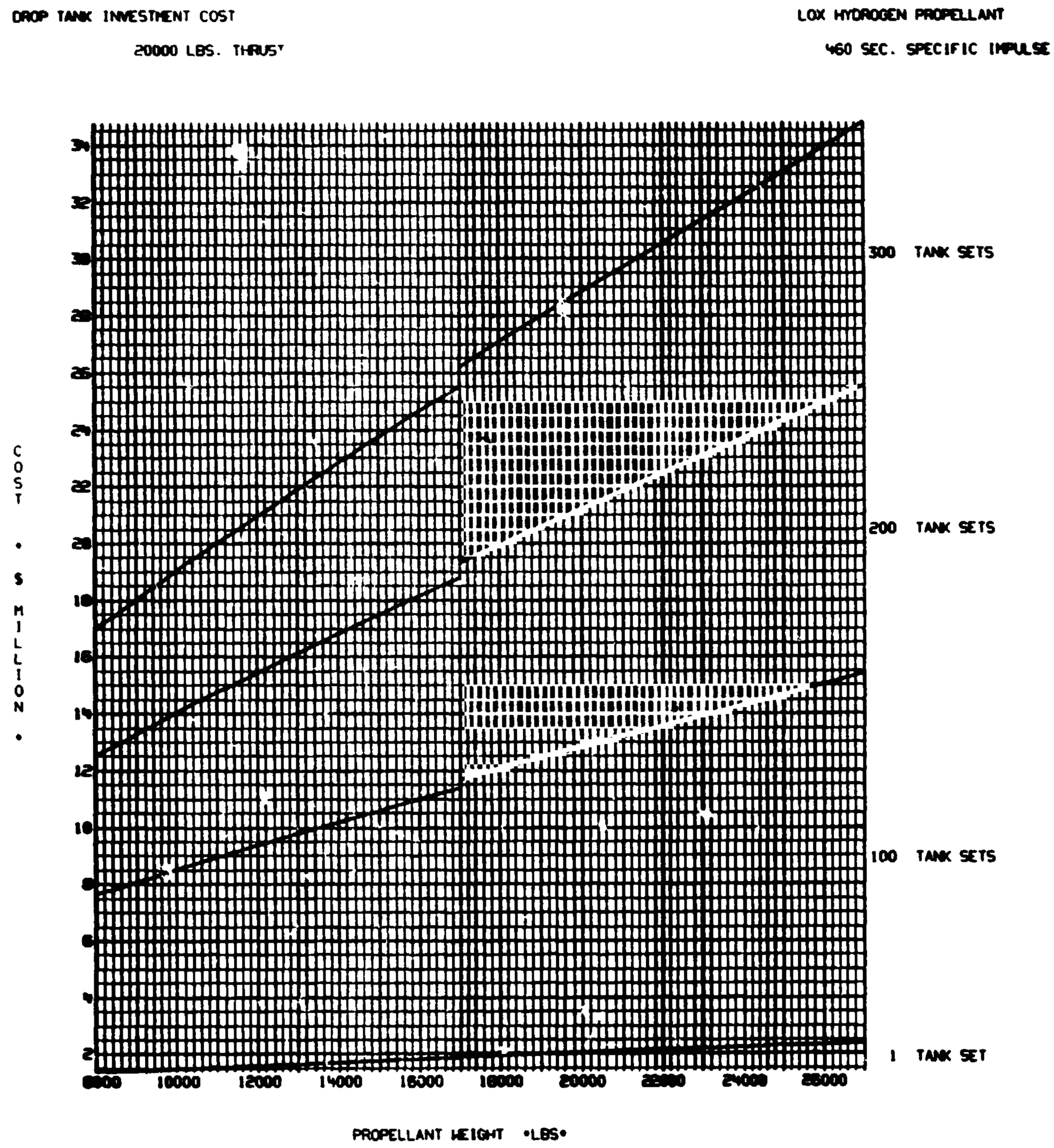

Figure 4-27. Parametric Investment Costs for LO_2/LH_2 Drop Tanks

OPERATIONS COSTS

OPERATIONS COSTS

The costs associated with maintaining a reusable Space Tug program through its twelve year operational phase (1979 - 1990) are reported in this section. The Operations phase includes all activities associated with preparing the Tug for launch (handling, checkout, fueling, countdown); all activities associated with flight of a reusable Tug (mission control, recovery); and all activities associated with reusable Tug refurbishment (inspection, repair and replacement of hardware as necessary, periodic major overhaul, and spares provisioning). The Operations phase also includes base management, direct range services, and facilities/equipment operation and maintenance.

Important assumptions made in estimating Operations phase costs were as follows:

- The costs of Government manpower and equipment for mission control, tracking and data acquisition were omitted
- Tug operations were assumed to take place at two sites, namely ETR and WTR

For definition of the individual WBS entries used in the Operations costs, see Chapter 2.

LO_2/LH_2 Single-Stage Tug Operations Costs

Point-cost data for Operations phase expenditures with LO_2/LH_2 reusable ground-based Tugs are presented in Tables 4-16 and 4-17. These costs are for single-stage Tugs sized at 36,300 lb and 50,200 lb propellant loading, respectively.

Parametric data on LO_2/LH_2 single-stage Tug operations costs are presented in Figures 4-28 through 4-31. These graphs cover selected activity-level-dependent elements of Tug operations only. Figures 4-28 and 4-29 comprise plots of follow-on spares costs as a function of propellant loading for reusable and expendable versions of the LO_2/LH_2 Tug, respectively; these are calculated on a total cost basis. Figures 4-30 and 4-31 are curves of other key Operations costs as a function of activity level; these are plotted on a cost-per-flight basis and are for reusable and expendable versions of the LF_2/LH_2 Tug, respectively.

Table 4-16. OPERATIONS COST BREAKDOWN FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG
(W_P = 36.3K)

Item	Cost ($ Millions)
Launch Operations and Services (493 Launches)	(186.599)
Launch Operations	110.487
Propellants	1.569
Facilities and Equipment Maintenance	7.007
Engineering Support	27.000
Program Management and Integration	27.000
Range/Base Support	13.536
Flight Operations (415 Reusable Tug Flights)	(22.352)
Communications and Control	6.768
Replacement Training	14.403
Recovery Operations	1.181
Refurbishment (401 Refurbishment Cycles)	(204.718)
Vehicle Maintenance	40.358
Follow-on Spares	164.360
Transportation Cost (511 Shuttle Flights)	2,555.000
Total	2,968.669

Table 4-17. OPERATIONS COST BREAKDOWN FOR LO_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG
(W_P = 50.2K)

Item	Cost ($ Millions)
Launch Operations and Services (519 Launches)	(194.147)
Launch Operations	116.731
Propellants	2.274
Facilities and Equipment Maintenance	7.606
Engineering Support	27.000
Program Management and Integration	27.000
Range/Base Support	13.536
Flight Operations (488 Reusable Tug Flights)	(22.568)
Communications and Control	6.768
Replacement Training	14.517
Recovery Operations	1.283
Refurbishment (471 Refurbishment Cycles)	(240.557)
Vehicle Maintenance	45.182
Follow-on Spares	195.375
Transportation Cost (562 Shuttle Flights)	2,810.000
Total	3,267.272

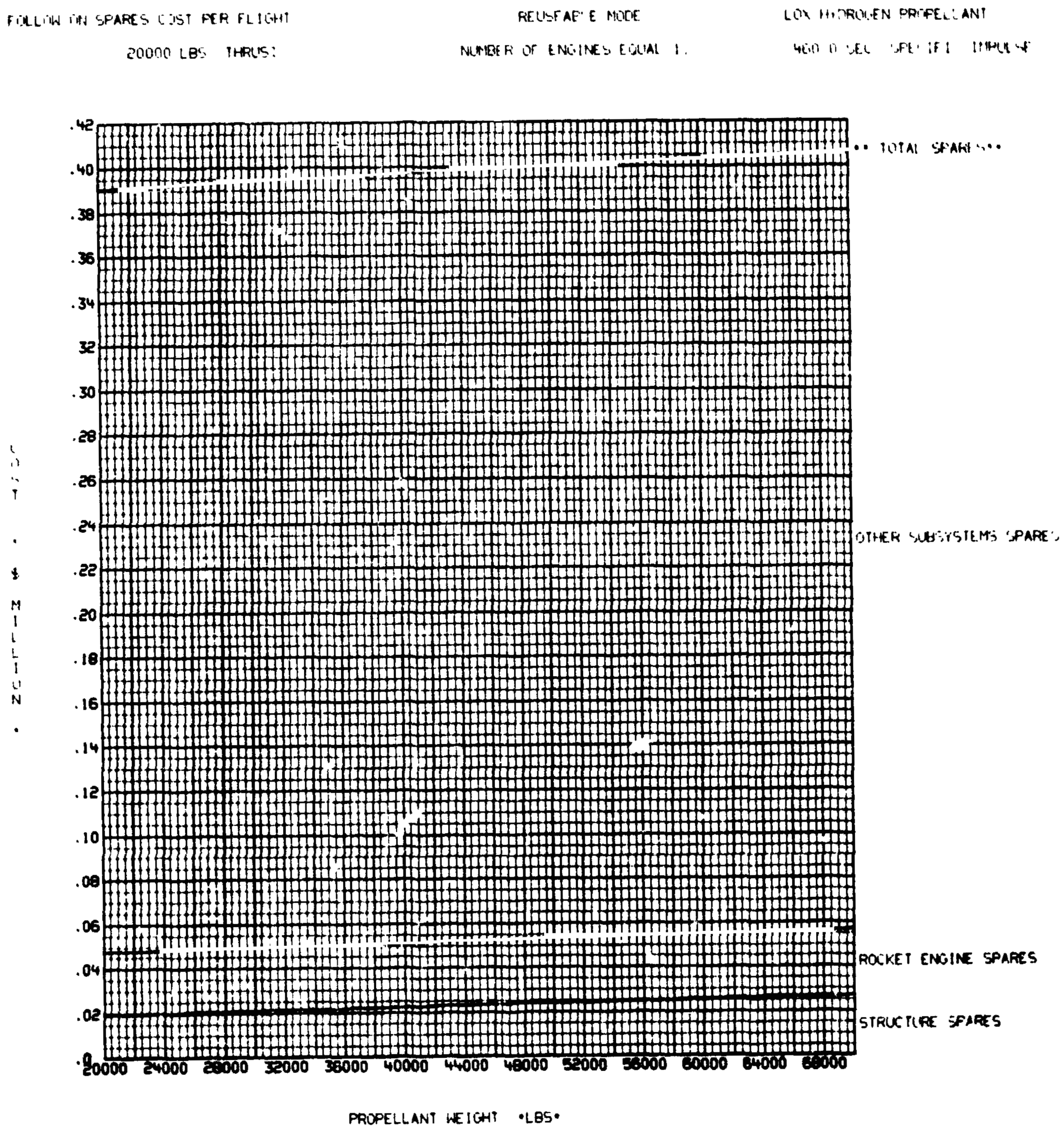

Figure 4-28. Parametric Follow-on Spares Costs for Reusable LO_2/LH_2 Tugs

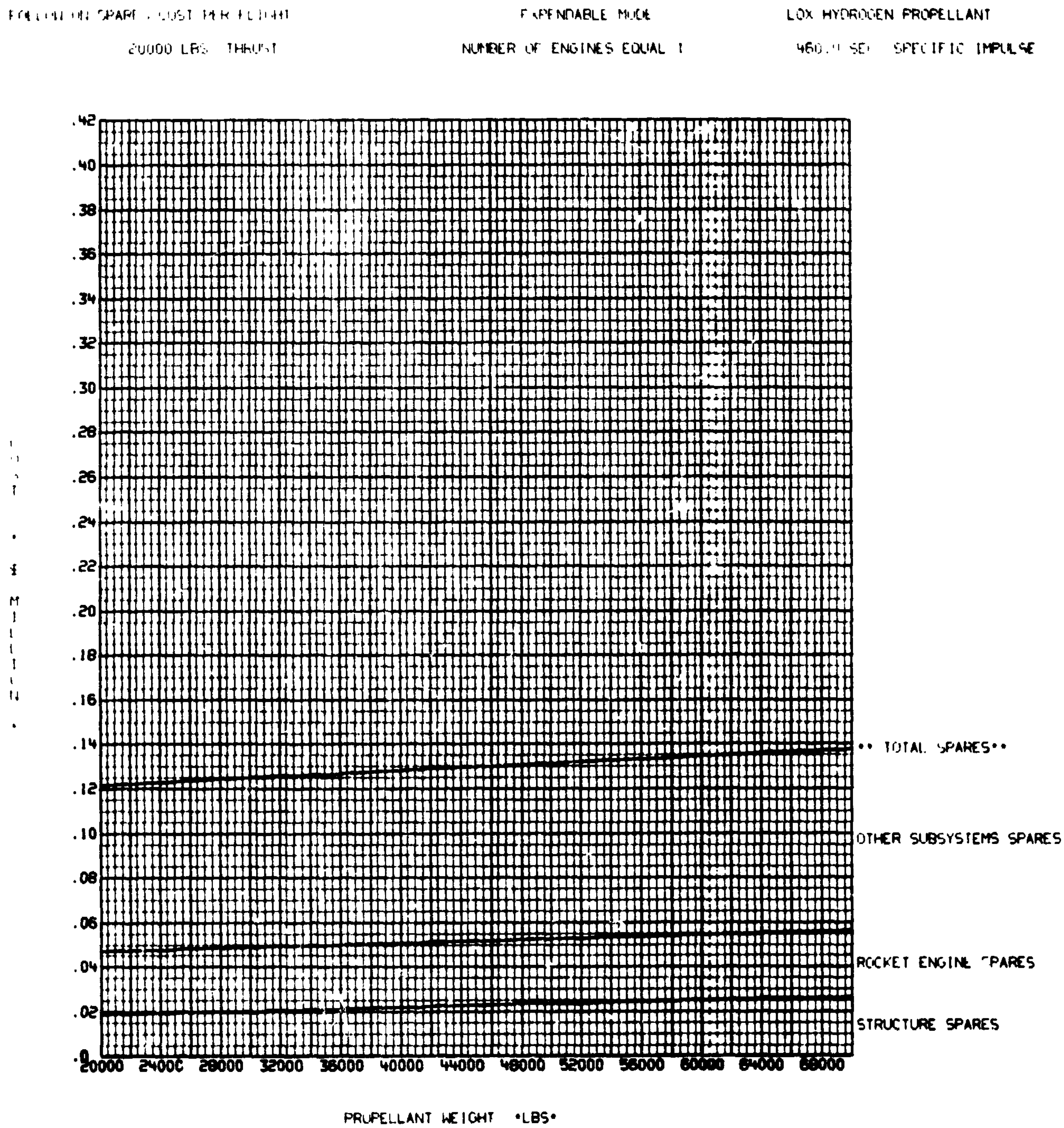

Figure 4-29. Parametric Follow-on Spares Costs for Expendable LO_2/LH_2 Tugs

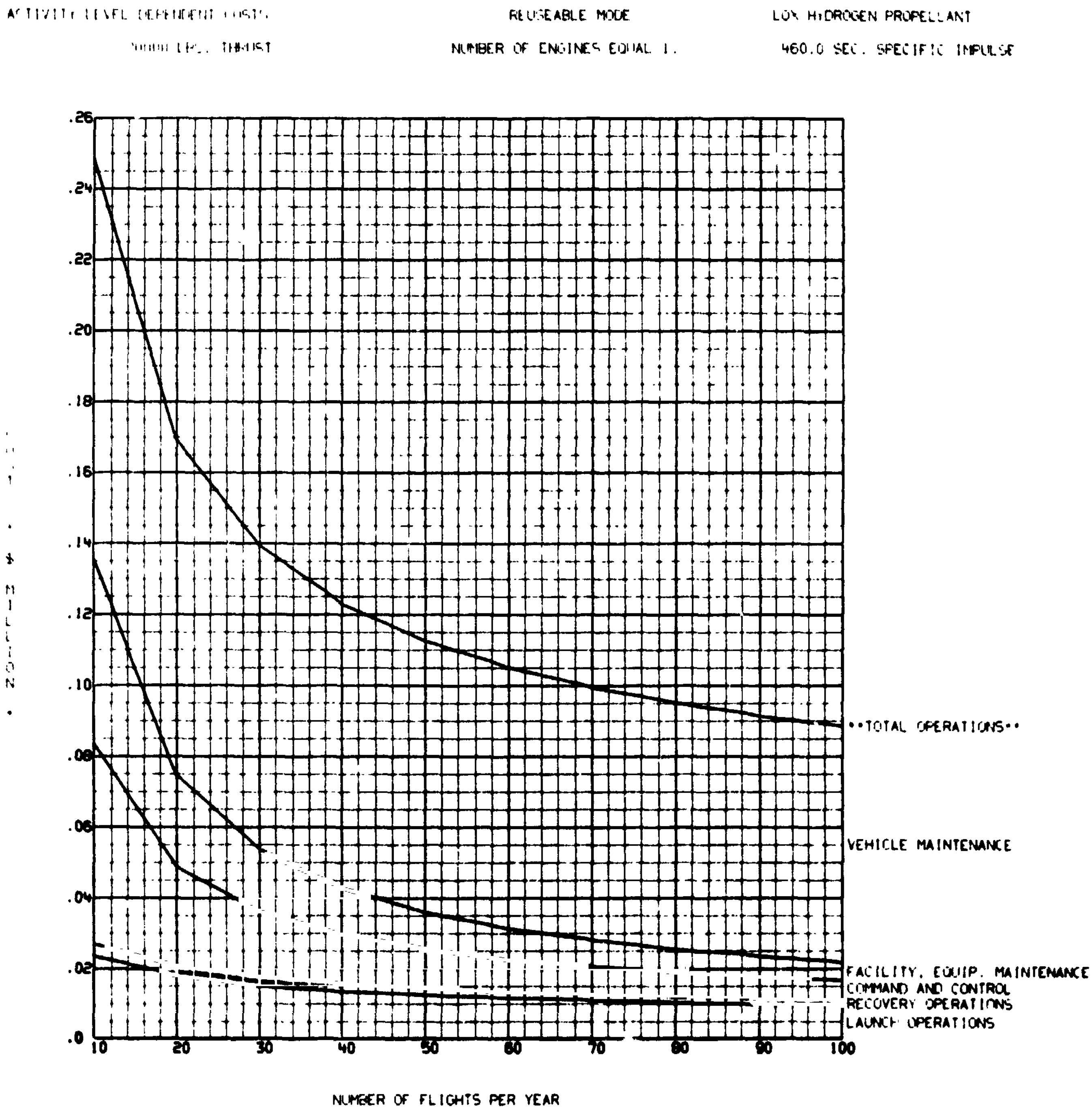

Figure 4-30. Parametric Operations Costs for Reusable LO_2/LH_2 Tugs

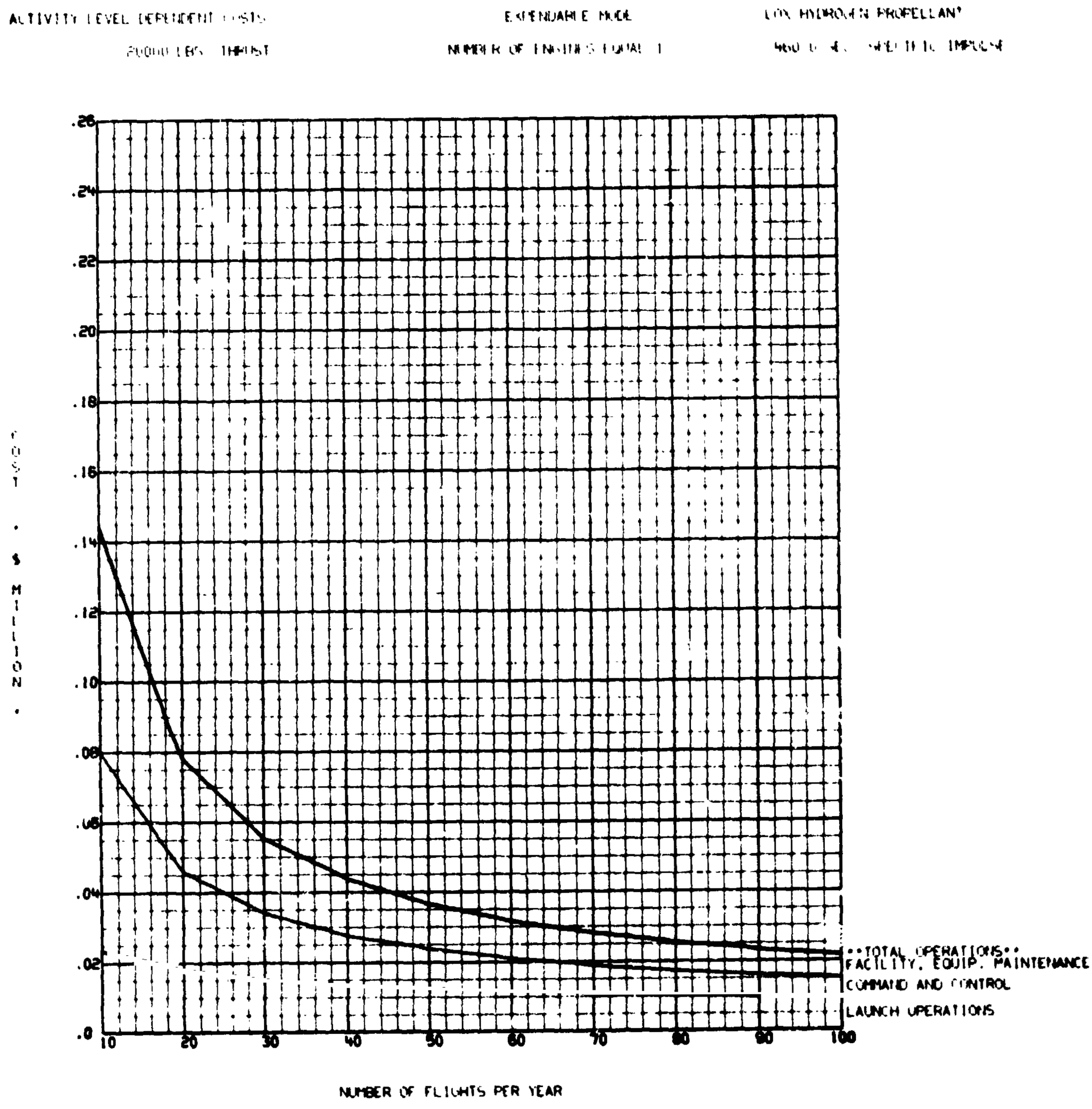

Figure 4-31. Parametric Operations Costs for Expendable LO_2/LH_2 Tugs

LF_2/LH_2 Single-Stage Tug Operations Costs

Point-cost data for the Operations phase expenditure requirements with a reusable ground-based LF_2/LH_2 Tug sized at 47,800 lb propellant loading are presented in Table 4-18. These costs reflect the added complexity of operations required with LF_2 oxidizer (compared to LO_2), as well as the added cost of the propellant itself.

Parametric data on Operations costs for reusable and expendable versions of the LF_2/LH_2 single-stage Tug are graphed in Figures 4-32 through 4-35. Figures 4-32 and 4-33 plot total follow-on spares costs as a function of Tug size. Figures 4-34 and 4-35 plot the cost per flight of key Operations activities as a function of the annual launch rate.

Table 4-18. OPERATIONS COST BREAKDOWN FOR LF_2/LH_2 SINGLE-STAGE, GROUND-BASED TUG
(W_p = 47.8K)

Item	Cost ($ Millions)
Launch Operations and Services (519 Launches)	(240.817)
Launch Operations	145.909
Propellants	20.443
Facilities and Equipment Maintenance	6.929
Engineering Support	27.000
Program Management and Integration	27.000
Range/Base Support	13.536
Flight Operations (500 Reusable Tug Flights)	(22.645)
Communications and Control	6.768
Replacement Training	14.570
Recovery Operations	1.307
Refurbishment (483 Refurbishment Cycles)	(255.332)
Vehicle Maintenance	53.143
Follow-on Spares	202.189
Transportation Cost (535 Shuttle Flights)	2,675.000
Total	3,193.794

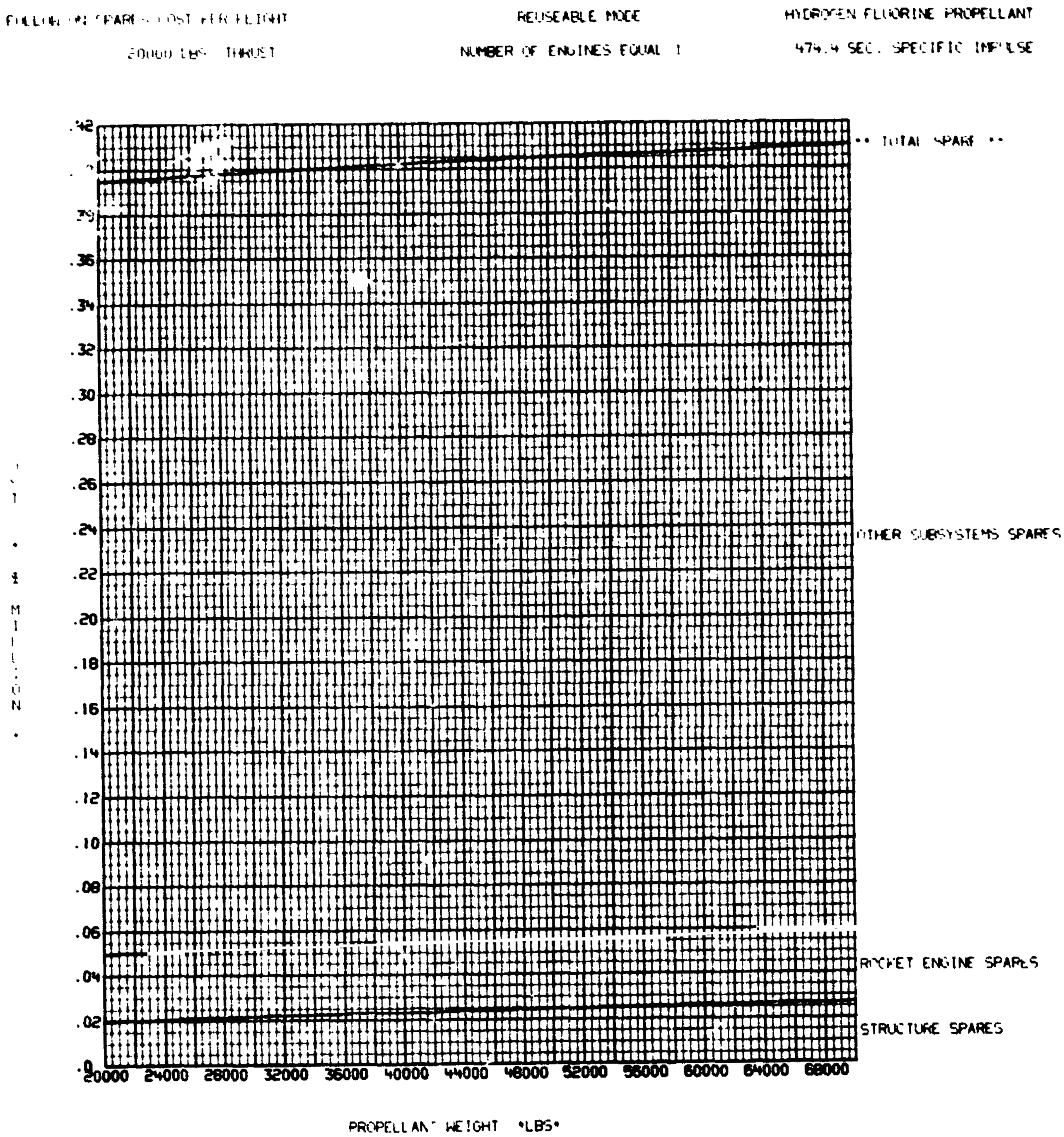

Figure 4-32. Parametric Follow-on Spares Costs for Reusable LF_2/LH_2 Tugs

C-2

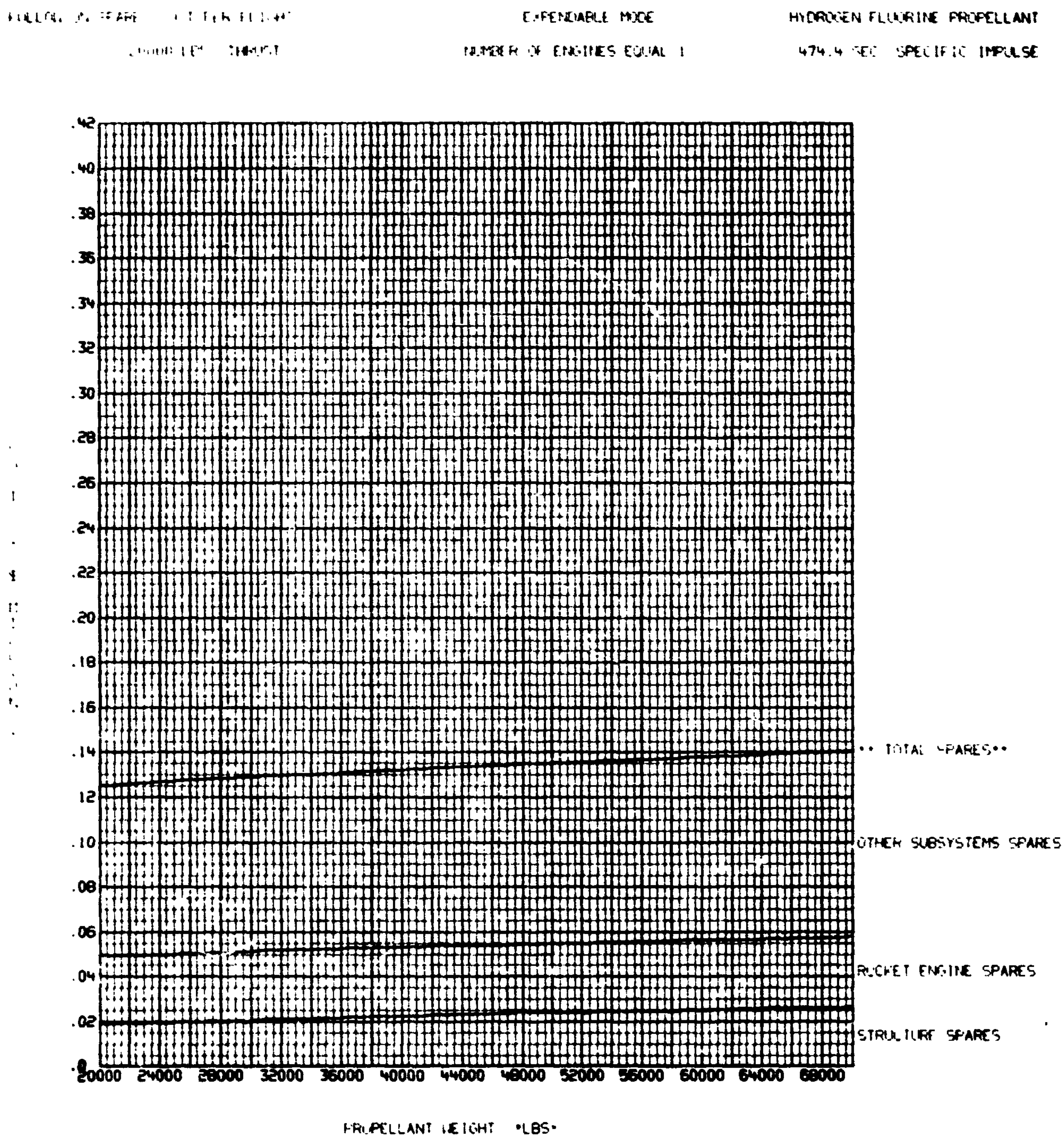

Figure 4-33. Parametric Follow-on Spares Costs for Expendable LF_2/LH_2 Tugs

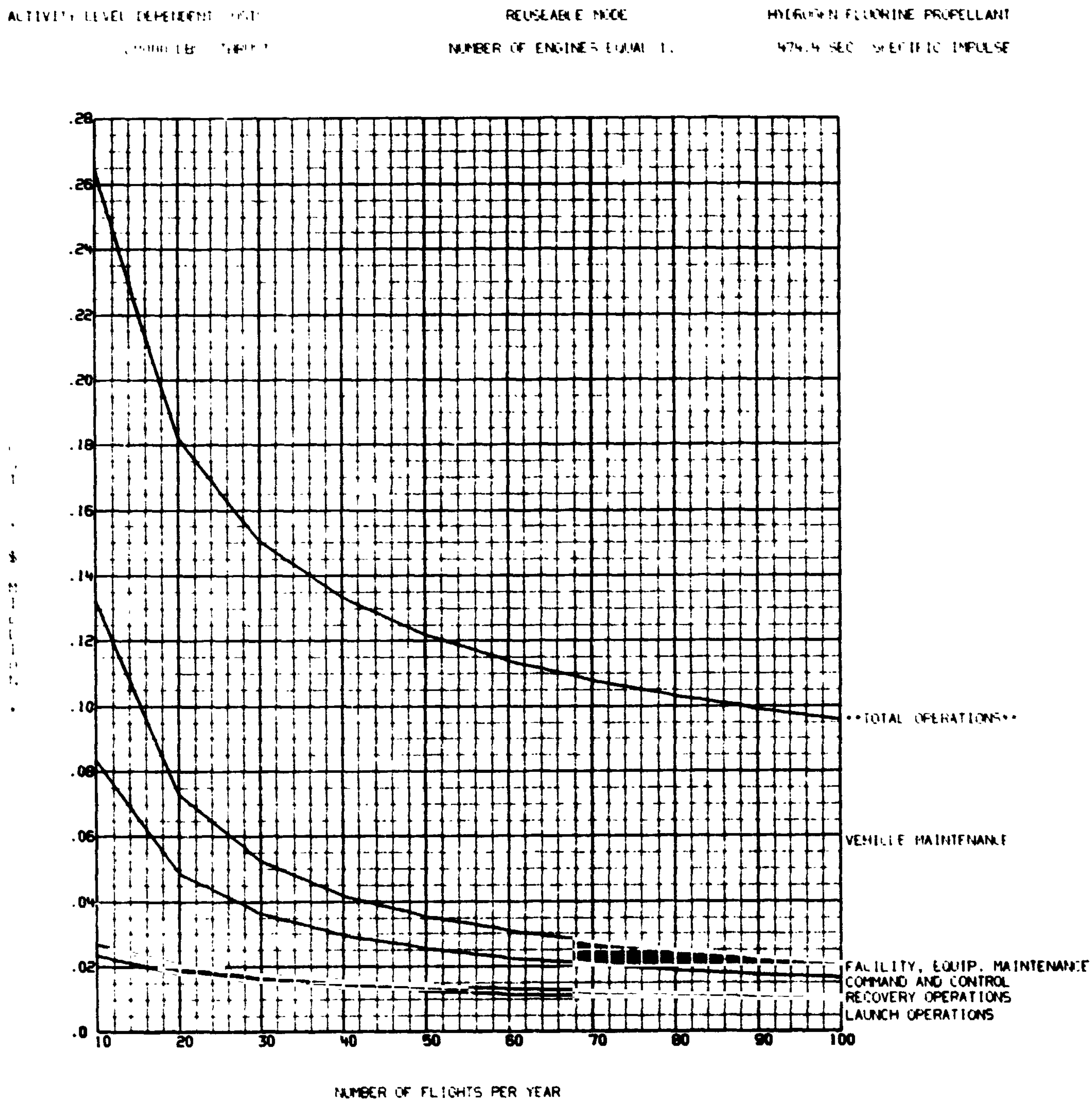

Figure 4-34. Parametric Operations Costs for Reusable LF_2/LH_2 Tugs

ACTIVITY LEVEL DEPENDENT COSTS   EXPENDABLE MODE   HYDROGEN FLUORINE PROPELLANT
20000 LBS. THRUST   NUMBER OF ENGINES EQUAL 1   474.4 SEC. SPECIFIC IMPULSE

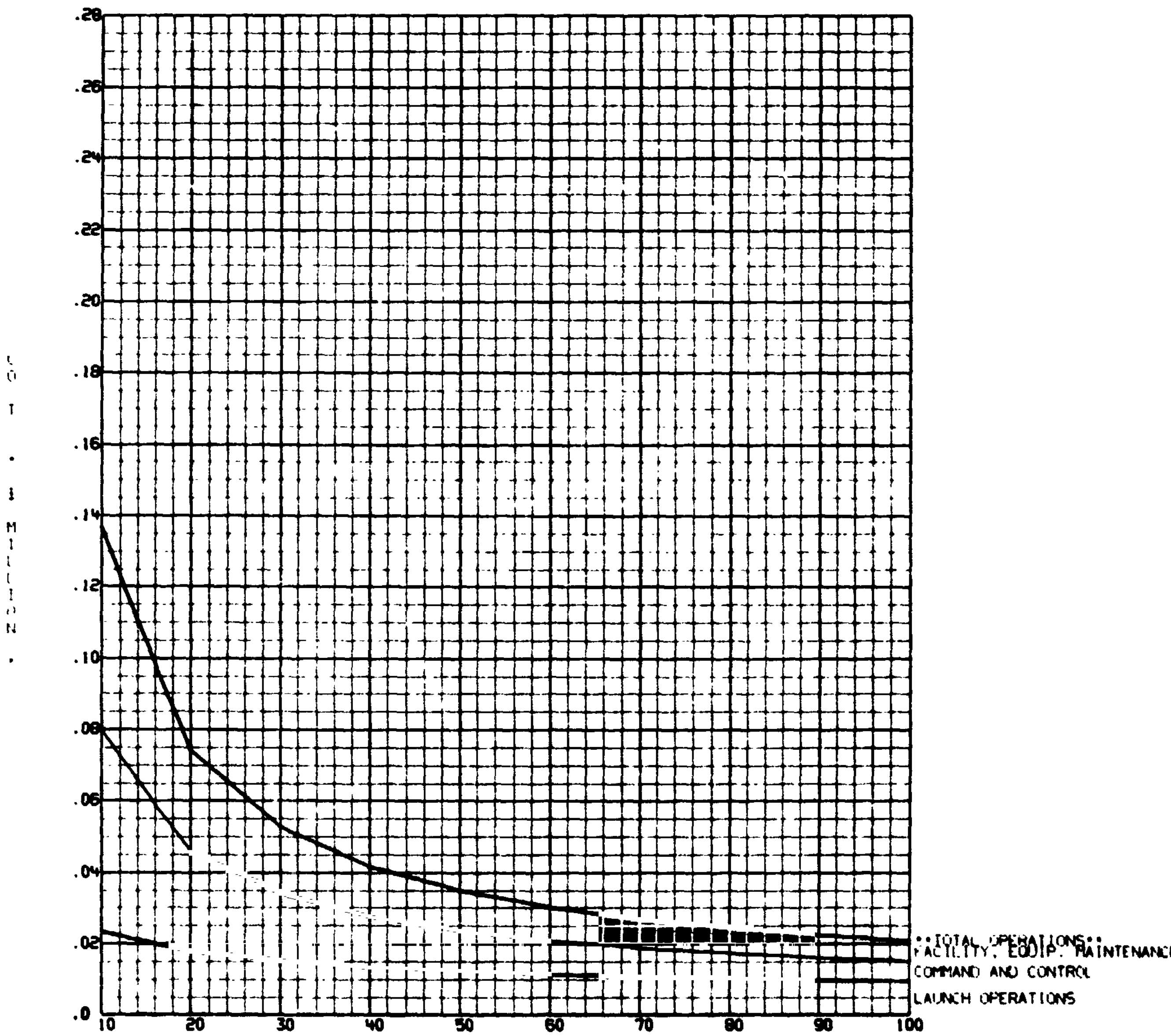

Figure 4-35. Parametric Operations Costs for Expendable LF_2/LH_2 Tugs

FLOX/CH_4 Single-Stage Tug Operations Costs

Point-cost data for the Operations phase expenditure requirements with a reusable ground-based FLOX/CH_4 Tug sized at 52,000 lb propellant loading are presented in Table 4-19. These costs reflect the added complexity of operations required with FLOX/CH_4 propellants (compared to LO_2/LH_2) as well as the added cost of the propellant itself.

Parametric data on Operations costs for the reusable and expendable versions of the FLOX/CH_4 single-stage Tug are graphed in Figures 4-36 through 4-39. Figures 4-36 and 4-37 plot total follow-on spares costs as a function of Tug size. Figures 4-38 and 4-39 plot the cost per flight of key Operations activities as a function of the annual flight rate.

Table 4-19. OPERATIONS COST BREAKDOWN FOR FLOX/CH_4 SINGLE-STAGE, GROUND-BASED TUG
(W_P = 52.0K)

Item	Cost ($ Millions)
Launch Operations and Services (506 Launches)	(235.570)
Launch Operations	141.985
Propellants	19.543
Facilities and Equipment Maintenance	6.506
Engineering Support	27.000
Program Management and Integration	27.000
Range/Base Support	13.536
Flight Operations (480 Reusable Tug Flights)	(22.024)
Communications and Control	6.768
Replacement Training	13.975
Recovery Operations	1.281
Refurbishment (463 Refurbishment Cycles)	(237.408)
Vehicle Maintenance	51.710
Follow-on Spares	185.698
Transportation Cost (522 Shuttle Flights)	2,610.000
Total	3,105.002

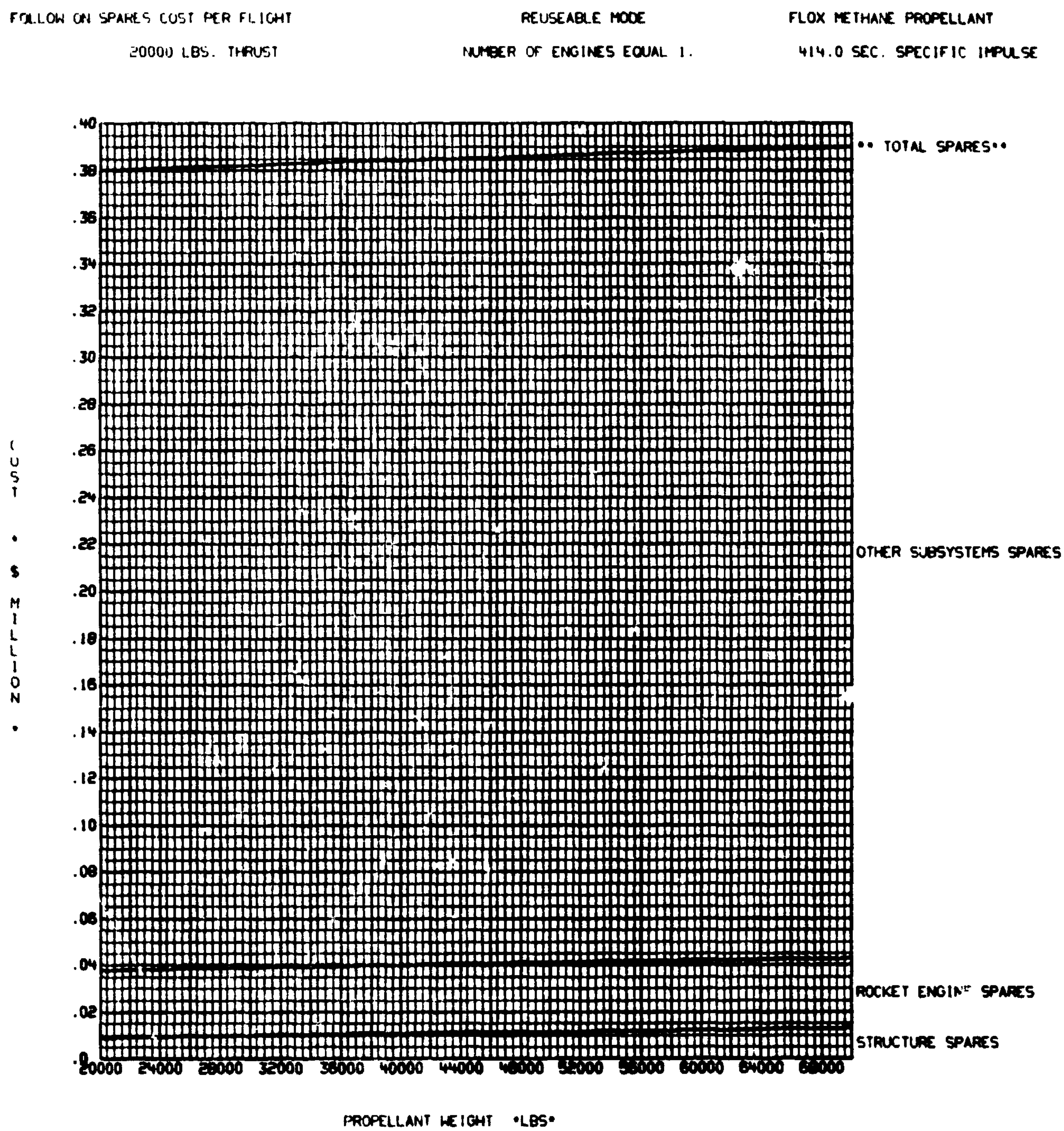

Figure 4-36. Parametric Follow-on Spares Costs for Reusable FLOX/CH_4 Tugs

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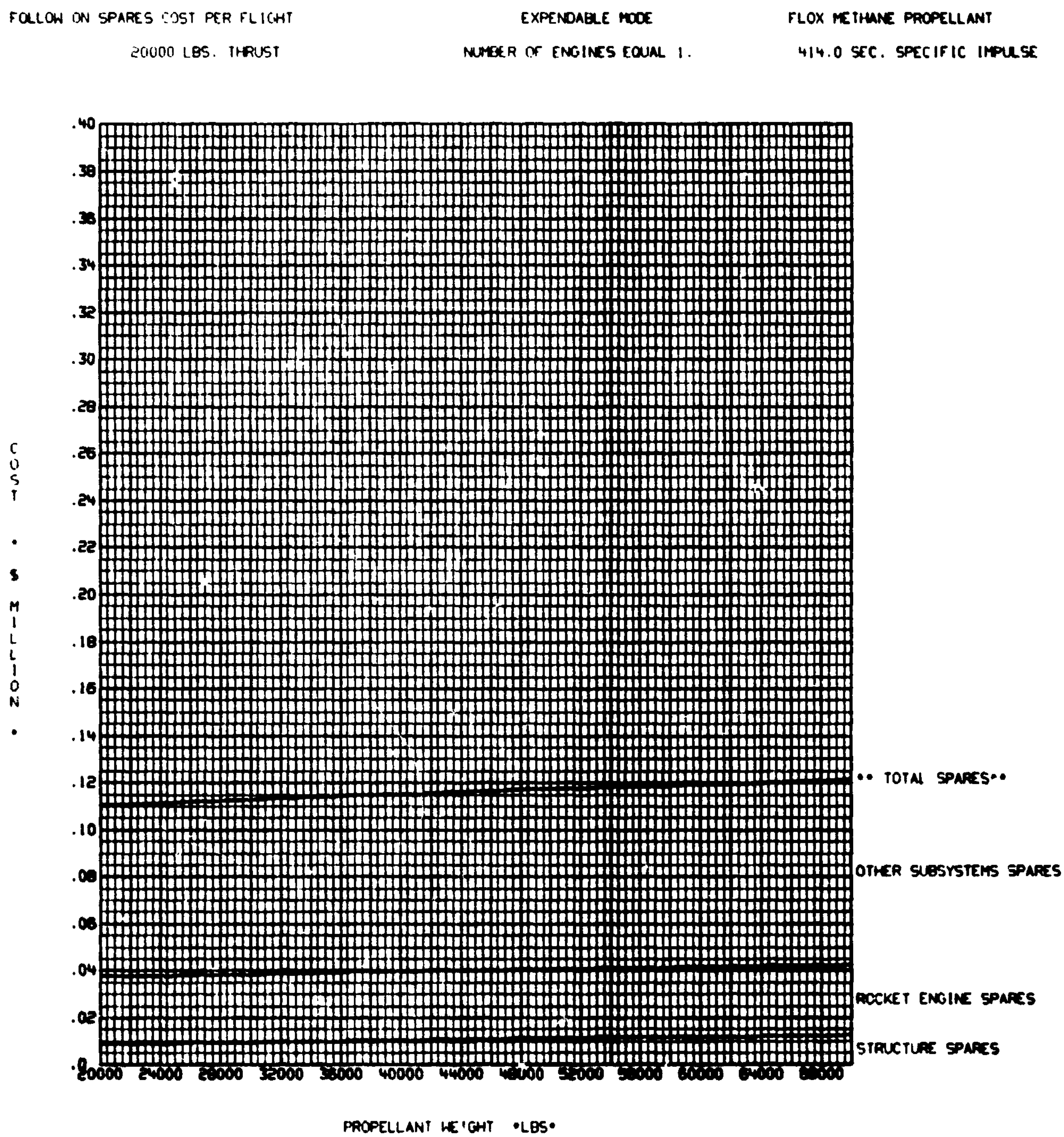

Figure 4-37. Parametric Follow-on Spares Costs for Expendable FLOX/CH_4 Tugs

ACTIVITY LEVEL DEPENDENT COSTS — REUSEABLE MODE — FLOX METHANE PROPELLANT

20000 LBS. THRUST — NUMBER OF ENGINES EQUAL 1 — 414.0 SEC. SPECIFIC IMPULSE

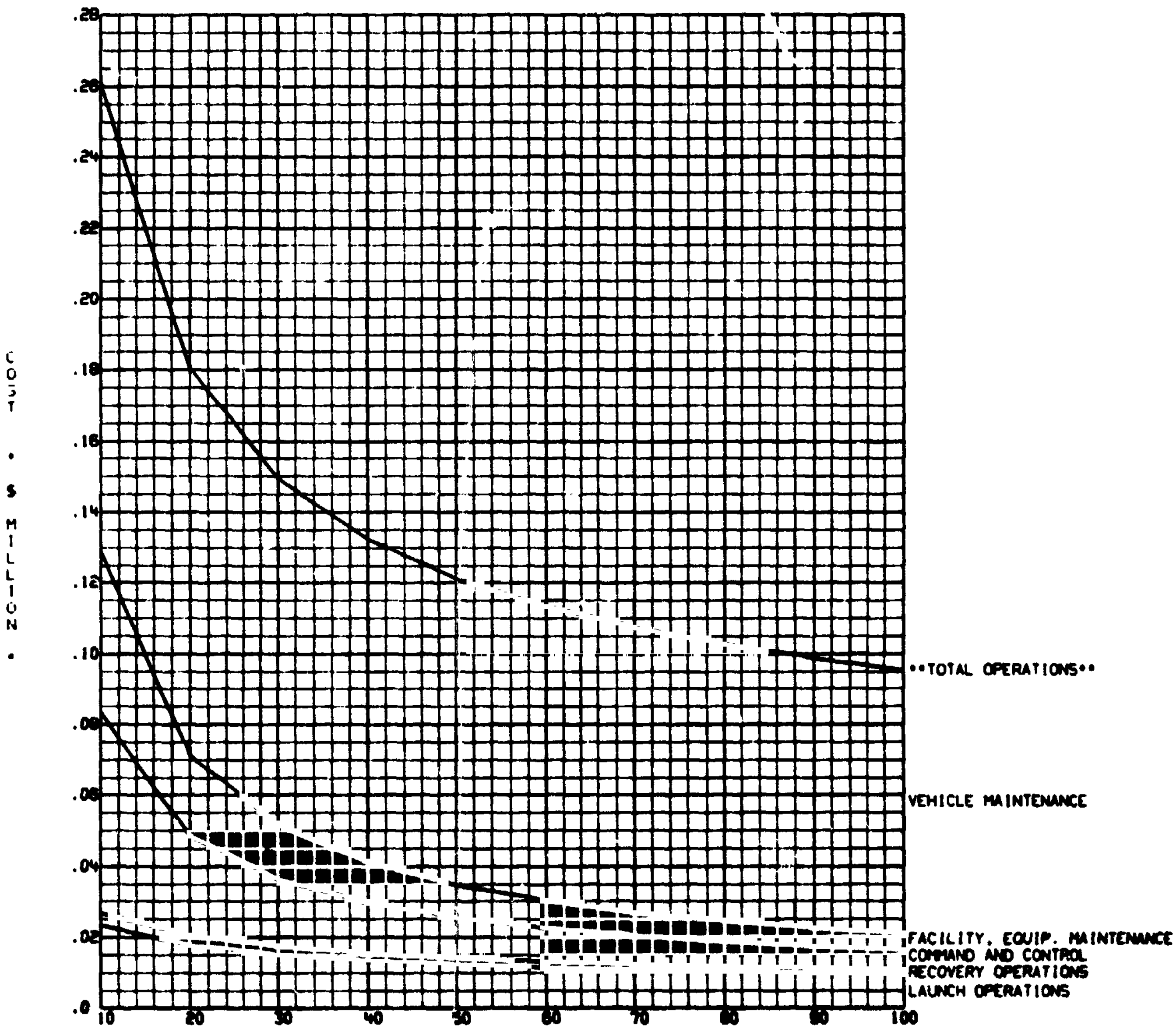

Figure 4-38. Parametric Operations Costs for Reusable FLOX/CH_4 Tugs

ACTIVITY LEVEL DEPENDENT COSTS — EXPENDABLE MODE — FLOX METHANE PROPELLANT
20000 LBS. THRUST — NUMBER OF ENGINES EQUAL 1. — 414.0 SEC. SPECIFIC IMPULSE

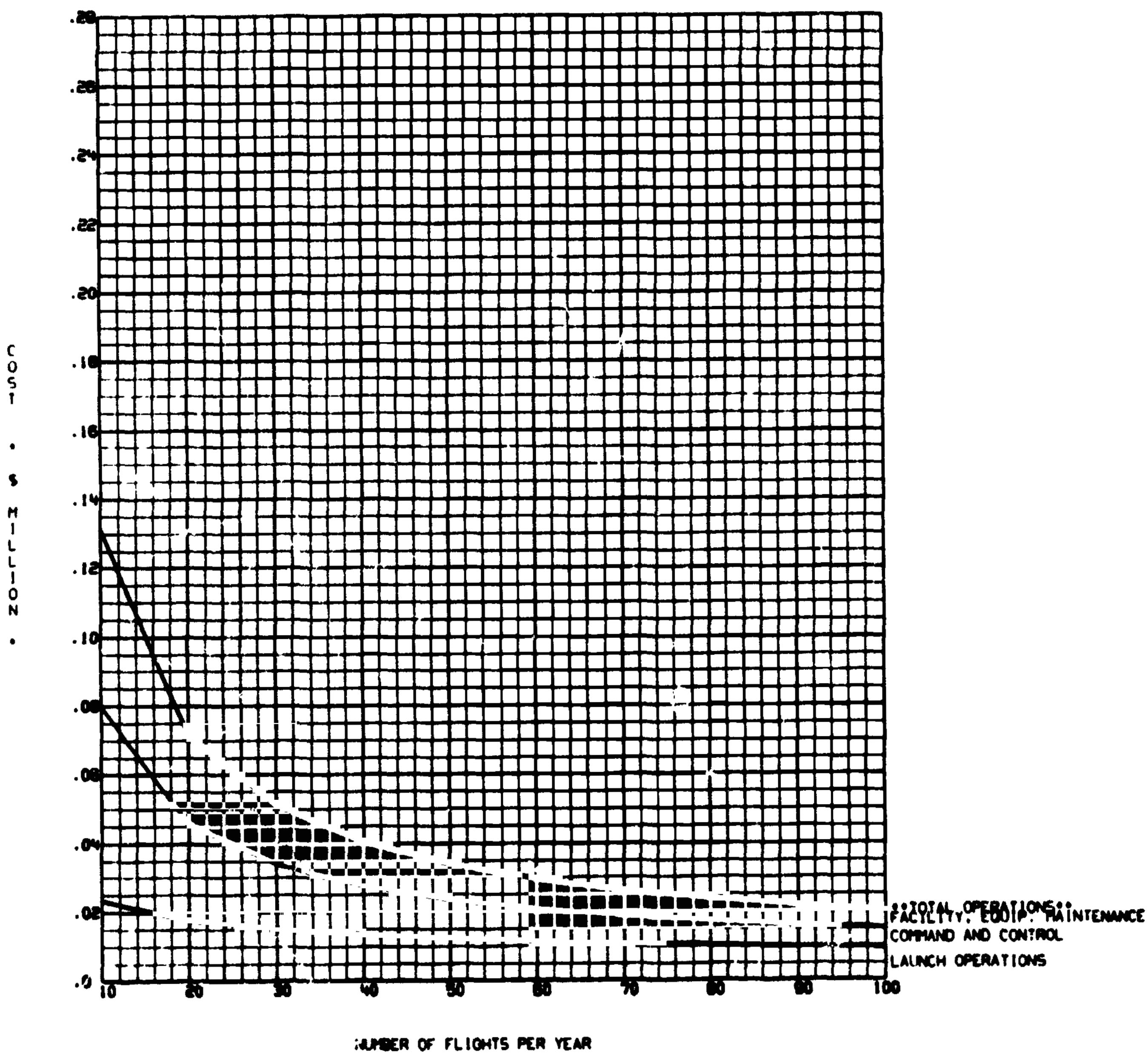

Figure 4-39. Parametric Operations Costs for Expendable FLOX/CH_4 Tugs

LO_2/LH_2 Stage-and-One-Half Tug Operations Costs

The point costs for Operations phase expenditure requirements with a stage-and-one-half LO_2/LH_2 Space Tug concept are presented in Table 4-20. These costs are for a concept with a core-stage propellant loading of 30,000 lb and a drop-tank propellant loading of 27,000 lb.

Table 4-20. OPERATIONS COST BREAKDOWN FOR LO_2/LH_2 STAGE-AND-ONE HALF, GROUND-BASED TUG
(CORE W_P = 30K)

Item	Cost ($ Millions)
Launch Operations and Services (496 Launches)	(186.790)
Launch Operations	111.205
Propellants	1.308
Facilities and Equipment Maintenance	6.741
Engineering Support	27.000
Program Management and Integration	27.000
Range/Base Support	13.536
Flight Operations (479 Flights with Core Stage Reuse)	(22.475)
Communications and Control	6.768
Replacement Training	14.428
Recovery Operations	1.279
Refurbishment (463 Core Stage Refurbishment Cycles)	(233.661)
Vehicle Maintenance	44.776
Follow-on Spares	188.885
Transportation Cost (628 Shuttle Flights)	3,140.000
Total	3,582.926

FUNDING REQUIREMENTS

The funding requirements, by fiscal year, of a reusable LO_2/LH_2 Space Tug (50,200 lb propellant loading) are graphed in Figure 4-40. This figure was presented to typify the expenditure pattern of the entire class of reusable Tugs. The funding curve was derived using development and procurement span data (e.g., 5 years for RDT&E) in combination with standard statistical spread functions. No smoothing of the expenditures was performed. These costs include only Tug expenditures (RDT&E, Investment, Operations); Shuttle user fees and payload costs were specifically excluded.

This characteristic reusable-Tug funding curve features a peak in funding during the early years (FY 1975 – 1979) primarily caused by RDT&E expenditures and secondarily by Investment phase requirements. The magnitude of the peak year requirement exceeds \$200 million. The RDT&E component of this funding can be alleviated slightly by a vigorous program of supporting research and technology in the FY 1973 – 75, and can be further decreased by accepting lower Tug performance (e.g., no retrieval capability; storable propellants). However, no appreciable reduction in the early-year peak can be achieved without phased introduction of the reusable Tug and use of the orbital injection stage for early operational missions.

Once the operational phase of the reusable Tug program arrives, funding levels decline to just over \$50 million per year. This efficiency in operations limits total Tug expenditures to \$1.41 billion, in contrast to \$1.64 billion for the most competitive orbit injection stage.

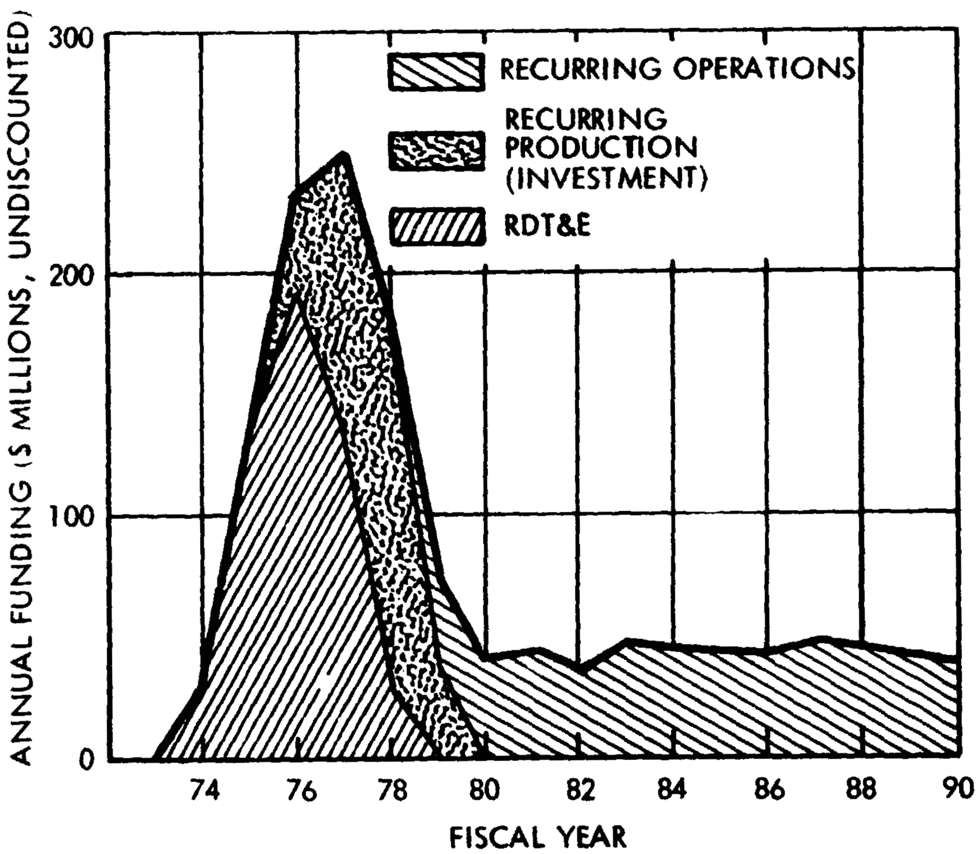

Figure 4-40. Reusable Tug (50.2K)LO_2/LH_2 Funding Requirements

PAYLOAD COSTS

Chapter 5

PAYLOAD COSTS AND CHARACTERISTICS

This final chapter in Volume III presents cost data — and other important characteristics — for the unmanned spacecraft delivered by the Space Tug system. The organization of this chapter is as follows. First the overall approach to payload costing is reviewed to establish a basis for the estimates that follow. Then the contents of the data sheets that make up the payload data base are described in detail to guide the reader in interpreting this information. Finally the actual payload data sheets for most of the unmanned spacecraft in the mission model are presented. This information covers NASA and applications-agency programs only; DoD payload data are contained in a separate classified appendix (limited distribution).

APPROACH

The starting point in the payload cost analysis was a mission model comprising 64 programs (483 spacecraft placements) that was supplied to Lockheed by NASA. This model was limited to those missions for which a Tug is potentially required; hence it excluded low-earth-orbit spacecraft directly deliverable by the Shuttle alone. User agencies represented in the model were NASA (both the Office of Space Sciences and the Office of Applications), the Department of Defense, and various non-NASA applications agencies. Data included with the model (augmented by Aerospace Corporation results from the STS Economic Analysis study) also provided the orbital parameters, sizes, weights (by subsystem), power requirements, and flight schedules for all of the baseline payloads considered in the mission model.

The costs for these baseline payloads were then calculated using a parametric cost methodology applied against the spacecraft weights and characteristics. The cost estimating relationships used to perform these computations were historically-derived curves of cost as a function of technical characteristics (primarily weight) for the principal subsystems of unmanned spacecraft. The resulting baseline payload costs

were checked against comparable estimates derived by Aerospace Corporation in the STS Economic Analysis study and found to be in agreement.

Having established the baseline spacecraft costs, the final step in the payload costing task was to develop algorithms to express the cost savings possible with Space Tug systems. Based on the work performed by Lockheed under the original Payload Effects Analysis study (NASw-2156) three classes of payload cost savings were identified for the Tug, namely:

- Mass/Volume: These are the savings possible when payload weight and volume capacity (in excess of baseline requirements) are available, and low-cost fabrication techniques can be used because of the relaxed design tolerances.
- Payload Retrieval and Reuse: These are savings achieved when a spacecraft retrieved from orbit is refurbished, experiments are replaced as needed, and the spacecraft is returned to operational service (in lieu of purchasing a new unit).
- Accessibility: These savings, formerly called risk acceptance, arise from the fact that less testing (both RDT&E and acceptance) can be allowed for spacecraft that are accessible for repair in case of failure on orbit.

The savings attainable with each of these three effects were quantified in the form of cost and weight estimating relationships, and other algorithms. These were automated into the logic of the Lockheed STAR/ANNEX program in such a way that appropriate low-cost spacecraft estimates could be generated as required by the available payload capability of a given Tug in a given mode.

PAYLOAD DATA

This section contains data on the costs and characteristics of the unmanned payloads. This information is arrayed on data sheets (one sheet per payload). Following is an explanation of the payload data sheets. The payload data sheets for all spacecraft except the DoD programs are presented in Tables 5-1 through 5-48. These are arranged in numerical order in accordance with their assigned number in the reference mission model. These sheets contain all of the mission and cost data necessary to compute and spread all of the cost increments of one program from the mission model. The data are grouped into blocks, details of which are given below. The major blocks are as follows:

- Mission identification
- Mission definition
- Acceptable mission modes
- Schedule of all cost producing events
- Listing of weights and costs
- Miscellaneous cost and weight parameters
- Cost spread parameters and miscellaneous data

The contents of each of these blocks is as follows:

Mission Identification. This gives the mission number in the so-called Fleming model of March 1971 and the mission title. The subfield is provided to allow for variance within a mission, such as sending the same payload to a variety of orbits.

Mission Definition. This lists the final orbit into which the payload is to be placed, the ΔV required (above the velocity in a circular orbit at 100 nm), payload life, and the number of active payloads required. The payload dimensions and density are for the baseline payload, before application of payload effects and repackaging; these dimensions are taken from Aerospace Corporation data.

Acceptable Mission Modes. This lists the possible payload modes (expendable or retrievable) and Tug modes (round trip placement and retrieval in one flight, placement only, retrieval only, expendable Tug) and states which modes may be used for the subject mission.

Schedule. The first two lines of the schedule are for expendable payloads and are taken from the mission model. The launch schedule also applies to payload placement when the payload is retrieved and refurbished (in the present study only refurbishment on the ground was considered). The retrieval schedule was developed by LMSC during the study; it is designed to minimize new buys and also to permit combinations of placement and retrieval on one flight as far as possible. The resulting new-payload acquisition schedule for a retrievable payload is then shown. The schedule of new-experiment RDT&E, for these cases in

which the experiment is changed every few years, is taken from Aerospace Corporation analyses. That part of operations cost associated with orbital support, independent of launch rate, is applied in every year in which an asterisk is shown.

Weight and Cost Parameters. Weights and costs are listed here by subsystem. These data are derived as follows:

- Baseline Weight — From Aerospace data.
- Low Cost Weight — From weight estimating relationships (WERs) developed by LMSC from results of Payload Effects Study, for full application of low-cost techniques.
- Baseline Costs — From LMSC cost estimating relationships (CERs)
- Low Cost — From LMSC CERs based on results of Payload Effects Study, for full application of low-cost techniques.

The sub-heading Risk denotes application of accessibility savings (formerly called risk acceptance) in which a cost reduction is made, at constant total mission reliability and confidence, because it is possible to check out a payload after placement and bring it back if it has failed. No Risk denotes costs when this effect is not applied. The factors in parentheses beside the cost tabulations for experiments, structures, and electrical power allow for complexity in these subsystems and are applied to the costs derived from the CERs for a complexity factor of unity.

The ratio of inert weight (less propellants) to total weight was maintained constant at the factor shown, and the propellant weights were computed accordingly. The "minimum weights" are stops to prevent the payload weight from ever going below the baseline weight for the expendable mode, or going below the baseline weight (as modified by providing refurbishability) for the retrievable mode. The weight increment for refurbishability is shown on the third line of the first column; it is derived from an LMSC WER and applies to either baseline or low-cost payloads if refurbishable. It results from spacecraft design modularization and hardware provisions for retrieval (e.g., rendezvous/docking equipment). Provision was made for fixing the weight of some subsystems (fifth line, second column) when it

was felt that low-cost techniques were not applicable. The low-cost payload weight included provision for refurbishability (for historical reasons). In order to interpolate (for partial application of cost reduction with weight increase) the weight changes due to low-cost techniques only, the factor (L/C – B/L – REF (L/C)), which represents this increase, was computed.

The accessibility savings (i.e., Risk Acceptance) were applied in full to retrievable payloads. For expendable payloads, which could still be checked out after reaching low earth orbit but before placement by the Tug, 40 percent of the full savings was applied (third column).

Cost Spread Parameters and Miscellaneous Data. These entries are largely self explanatory. The duration of the R&D phase (or phases, if new-experiment R&D is required) and the investment phases (purchase of new units), and their spread-function shapes are given. The launch-rate-dependent operating cost is that associated with a launch and is applied in the years of launch. The launch-independent costs listed are per-year per-vehicle active on orbit, and are applied as shown in the schedule. The Fixed Portion Initial Investment (usually zero) provides for additional ground facilities if required by the mission. Provision was made (but not used) for retrieving less than 100 percent of the placed payload weight. The Cost Confidence entry is a subjective evaluation of the validity of the cost data.

Table 5-1. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 2

MISSION FLEMING NUMBER: 2 SUBFIELD: 0 NAME: RADIO ASTRONOMY EXPLORER ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NAS14B ** (BASELINE & LOW COST) **

INCLINATION: 28.50 DEGREES ORBIT: 19323N(P) / 19323N(A)
ΔV: 12990. FT/SEC AVERAGE POWER: 100. WATTS
LIFE: 3.0 YEARS SIZE: DIAMETER 5.0 FT. LENGTH 4.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2 DENSITY: 11.3 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		2	1			1	2		1			2							
NEW UNITS (EXPENDABLE)		2	1			1	2		1			2							
NUMBER OF RETRIEVALS						1	2		1	1									
NEW UNITS + N-R INV (REUSEABLE)		2	1			1													
EXPERIMENT R&D APPLICATION		*			*			*			*								
OPERATION INDEPENDENT COST APPLICATION		*	*	*	*	*	*	*	*	*	*	*	*	*					

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *P/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	30.	73.	.480	.412	.412	.118	.093	.093
EXPERIMENT MISSION EQUIPMENT	253.	459.	31.003 (2.40)	25.136	23.376	2.853 (1.90)	2.317	2.143
STRUCTURES AND MECHANISMS	200.	947.	9.600 (2.00)	6.321	5.563	.358	.649	.649
ELECTRICAL POWER	161.	319.	9.580 (1.78)	7.100	6.390	1.538	1.594	1.323
STABILITY & CONTROL	40.	91.	7.621	6.525	5.612	.580	.731	.645
ATTITUDE CONTROL	14.	34.	1.500	.886	.798	.075	.079	.079
PROPULSION	30.	81.	7.300	12.468	11.221	.442	.907	.907
TRACKING & TELEMETRY	50.	56.	13.423	10.752	9.677	1.975	1.690	1.538
ENVIRONMENTAL CONTROL	15.	65.	1.175	1.052	.947	.165	.180	.180
EXPENDABLE PROP. & GASSES	100.	269.	.000	.000	.000	.000	.000	.000
** TOTAL **	890.	2394.	81.682	70.653	63.996	8.101	8.210	7.557

MIN. INERT WT. EXPENDABLE P/L 790. REFURB. INERT WT. 519.
MIN. TOTAL WT. EXPENDABLE P/L 893. REFURB. PROP. WT. 66.
REFURB. L/C S/S WT. 584.
REFURB. TOTAL WT. REUSEABLE P/L 584. L/C SUBSYSTEMS WT. 2394.
MIN. PROPELLANT WT. REUSEABLE P/L 166. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1309. FACTOR: (L/C-P/L-REF(L/C)) = 919.34
MIN. TOTAL WT. REUSEABLE P/L 1474. RATIO: INERT WT./TOTAL WT. = .88764

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.7595	.7038
TOTAL R&D	6.6575	2.6630
TOTAL UNIT	.6529	.2612

R&D PHASE: 3.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY... LAUNCHES)

OPERATING COST: DEPENDENT $ 1.280 MILLION/LAUNCH, INDEPENDENT $ 2.024 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-2. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION No. 3

MISSION FLEMING NUMBER: 3 SUBFIELD: 0 NAME: UPPER ATMOSPHERE EXPLOR ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NSP-1 ** (BASELINE & LOW COST) **

INCLINATION: 90.00 DEGREES
ΔV: 2500. FT/SEC
LIFE: 1.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1

ORBIT: 180M(P) / 1800M(A)
AVERAGE POWER: 100. WATTS
SIZE: DIAMETER 4.0 FT, LENGTH 8.0 FT,
DENSITY: 11.9 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1	1	1							
NUMBER OF RETRIEVALS		1	1	1	1	1	1	1	1	1	1								
NEW UNITS - N-R INV (REUSEABLE)	1	1																	
EXPERIMENT R&D APPLICATION	•		•		•		•		•		•								
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•							

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	40.	91.	.950		.460	.460	.128		.099	.099
EXPERIMENT MISSION EQUIPMENT	100.	174.	7.000	(1.00)	4.267	3.968	.820	(1.00)	.653	.604
STRUCTURES AND MECHANISMS	240.	1037.	7.072	(1.34)	4.427	4.072	.403		.690	.690
ELECTRICAL POWER	90.	193.	3.960	(1.00)	3.047	2.742	1.197		1.295	1.075
STABILITY & CONTROL	80.	150.	8.500		6.439	5.531	1.250		1.289	1.186
ATTITUDE CONTROL	70.	973.	3.500		3.817	3.435	.505		.703	.703
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	100.	184.	12.800		14.773	13.296	2.880		3.238	2.946
ENVIRONMENTAL CONTROL	30.	31.	1.850		1.640	1.476	.320		.293	.293
EXPENDABLE PROP. & GASSES	450.	1494.	.000		.000	.000	.000		.000	.000
** TOTAL **	1200.	3983.	49.312		39.869	34.980	7.503		8.259	7.596

MIN. INERT WT. EXPENDABLE P/L 750.
MIN. TOTAL WT. EXPENDABLE P/L 1200.

REFURB. TOTAL WT. REUSEABLE P/L 929.
MIN. PROPELLANT WT. REUSEABLE P/L 798.
MIN. INERT WT. REUSEABLE P/L 1331.
MIN. TOTAL WT. REUSEABLE P/L 2129.

REFURB. INERT WT. 581.
REFURB. PROP. WT. 348.
REFURB. L/C S/S WT. 929.
L/C SUBSYSTEMS WT. 3983.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C-B/L-REF(L/C)) = 1833.70
RATIO: INERT WT./TOTAL WT. = .62508

RISK SAVINGS ($M)	*REUSE*	*EXPEND*
R&D EXPERIMENT	.2987	.1195
TOTAL R&D	4.0820	1.6328
TOTAL UNIT	.6634	.2654

R&D PHASE: 2.5 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 2 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.200 MILLION/LAUNCH, INDEPENDENT $ 1.470 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 180.00 N.M. APOGEE ALTITUDE: 1800.00 N.M.
INITIAL ORBIT INCLINATION: 90.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-3. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 4

```
MISSION FLEMING NUMBER:   4      SUBFIELD: 0        NAME: MAGNETOSPHERE EXPLORER          ** MISSION / PAYLOAD DATA  **
MISSION CODE NUMBER: NSP-2                                                                ** (BASELINE & LOW COST)   **

INCLINATION: 90.00 DEGREES                           ORBIT: 1000M(P)     / 20000M(A)
DV:   10720. FT/SEC                                  AVERAGE POWER:     100. WATTS
LIFE: 3.0 YEARS                                      SIZE:  DIAMETER  6.0 FT.  LENGTH  8.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  3               DENSITY:   4.4 LBS/FT3

ACCEPTABLE MISSION MODES:
    ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                     ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
    ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                     ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )

  **LAUNCH SCHEDULE:  **         **YEAR**  79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
NUMBER OF LAUNCHES                          1  1  1  1  1  1  1  1  1  1  1  1
NEW UNITS (EXPENDABLE)                      1  1  1  1  1  1  1  1  1  1  1  1
NUMBER OF RETRIEVALS                                 1  1  1  1  1  1  1  1
NEW UNITS + N&R INV (REUSEABLE)             1  1  1  1
EXPERIMENT R&D APPLICATION                  *     *     *     *     *     *
OPERATION INDEPENDENT COST APPLICATION      *  *  *  *  *  *  *  *  *  *  *  *  *  *

** WEIGHTS & COSTS: **        **WEIGHT (LBS)**            **R&D COST ($M)**                    **UNIT COST ($M)**
                               *B/L*  *L/C*        *BASELINE*        *LOW COST*          *BASELINE*          *LOW COST*
  **SUBSYSTEM**                                                  *NO RISK* *RISK*                        *NO RISK* *RISK*
ADAPTER                          35.    82.          .523             .437     .437        .124               .096     .095
EXPERIMENT MISSION EQUIPMENT    100.   174.        12.124 (1.00)     7.390    6.873       1.550 (1.90)       1.241    1.148
STRUCTURES AND MECHANISMS       215.   983.        11.880 (2.40)     7.817    6.879        .376               .666     .566
ELECTRICAL POWER                 90.   193.         6.914 (1.75)     5.333    4.799       1.197              1.295    1.075
STABILITY & CONTROL              70.   142.        13.077           10.049    8.642       1.090              1.146    1.054
ATTITUDE CONTROL                 60.   495.         3.250            3.538    3.185        .472               .627     .627
PROPULSION                        0.     0.          .000             .000     .000        .000               .000     .000
TRACKING & TELEMETRY            103.   184.        22.170           25.388   23.029       2.880              3.238    2.946
ENVIRONMENTAL CONTROL            30.    81.         1.650            1.640    1.476        .320               .293     .293
EXPENDABLE PROP. & GASSES       300.  1000.          .003             .000     .000        .000               .000     .000
    ** TOTAL **                1000.  3332.        71.785           61.792   55.320       7.257              8.601    7.905

MIN. INERT WT.      EXPENDABLE P/L   700.     REFURB. INERT WT.       542.
MIN. TOTAL WT.      EXPENDABLE P/L  1000.     REFURB. PROP. WT.       232.       *RISK SAVINGS ($M)* *REUSE,**EXPEND.*
                                              REFURB. L/C S/S WT.     774.           R&D EXPERIMENT      .5173     .2069
  REFURB. TOTAL WT. REUSEABLE P/L    774.     L/C SUBSYSTEMS WT.     3332.           TOTAL  R&D         6.4721    2.5888
MIN. PROPELLANT WT. REUSEABLE P/L    532.     FIXED SUBSYSTEMS WT.      0.           TOTAL  UNIT         .6963     .2785
MIN. INERT WT.      REUSEABLE P/L   1242.     FACTOR: (L/C-B/L-REF(L/C)) = 1558.06
MIN. TOTAL WT.      REUSEABLE P/L   1774.     RATIO: INERT WT./TOTAL WT. =  .70000

     R&D PHASE: 3.0 YEARS     R&D SPREAD  50% TIME AT .40 COST
     NEW EXPERIMENT R&D: YES     ( EVERY  2 LAUNCHES )

     OPERATING COST:  DEPENDENT $  1.250 MILLION/LAUNCH,  INDEPENDENT $  2.294 MILLION/YEAR

     FIXED PORTION INITIAL INVESTMENT: $   .000 MILLION
     INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST                P/L COST CONFIDENCE: FAIR

     PERIGEE ALTITUDE:  1000.00 N.M.                        APOGEE ALTITUDE: 20000.00 N.M.
     INITIAL ORBIT INCLINATION:  90.00 DEGREES              TUG MISSION DURATION:    .00 HOURS

     % RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
```

Table 5-4. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 5

MISSION FLEMING NUMBER: 5 SUBFIELD: 0 NAME: NEAR INPLANETARY EXPLOR ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NSP.5 ** (BASELINE & LOW COST) **

INCLINATION: 28.50 DEGREES ORBIT: 1.0A.U. / ESCAPE
AV: 12000. FT/SEC AVERAGE POWER: 300. WATTS
LIFE: 3.0 YEARS SIZE: DIAMETER 4.0 FT. LENGTH 6.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2 DENSITY: 8.0 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1) ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2) ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1		1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1		1							
EXPERIMENT R&D APPLICATION	•		•		•		•		•			•							
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•	•					

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**		**R&D COST ($M)**			**UNIT COST ($M)**		
	B/L	*L/C*	*BASELINE*	*LOW COST*		*BASELINE*	*LOW COST*	
SUBSYSTEM				*NO RISK*	*RISK*		*NO RISK*	*RISK*
ADAPTER	20.	53.	.393	.353	.353	.104	.094	.084
EXPERIMENT MISSION EQUIPMENT	150.	267.	14.029 (1.00)	8.623	8.019	2.050 (1.90)	1.636	1.515
STRUCTURES AND MECHANISMS	120.	698.	7.263 (2.00)	4.920	4.330	.252	.528	.528
ELECTRICAL POWER	100.	211.	7.353 (1.75)	5.614	5.055	1.250	1.345	1.116
STABILITY & CONTROL	30.	72.	5.716	5.226	4.495	.420	.544	.500
ATTITUDE CONTROL	33.	213.	2.25-	2.290	2.061	.195	.327	.327
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	70.	118.	17.216	18.517	16.665	2.390	2.540	2.312
ENVIRONMENTAL CONTROL	20.	71.	1.403	1.280	1.152	.215	.224	.224
EXPENDABLE PROP. & GASSES	60.	189.	.003	.000	.000	.000	.000	.000
** TOTAL **	600.	1894.	55.611	46.827	42.131	6.856	7.227	6.604

MIN. INERT WT. EXPENDABLE P/L 540. REFURB. INERT WT. 429.
MIN. TOTAL WT. EXPENDABLE P/L 600. REFURB. PROP. WT. 48.
REFURB. L/C S/S WT. 477.
REFURB. TOTAL WT. REUSEABLE P/L 477. L/C SUBSYSTEMS WT. 1894.
MIN. PROPELLANT WT. REUSEABLE P/L 108. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 969. FACTOR: (L/C-B/L-REF(L/C)) = 816.82
MIN. TOTAL WT. REUSEABLE P/L 1077. RATIO: INERT WT./TOTAL WT. = .90000

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.6036	.2414
TOTAL R&D	4.6961	1.8784
TOTAL UNIT	.6234	.2494

R&D PHASE: 2.5 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 2 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.110 MILLION/LAUNCH, INDEPENDENT $ 1.708 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: .00 N.M. APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-5. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 7

```
MISSION FLEMING NUMBER:   7      SUBFIELD: D       NAME: GRAVITY RELATIVITY EXPER        ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NSP-6                                                               ** (BASELINE & LOW COST)  **

INCLINATION: 90,00 DEGREES                         ORBIT: 500M(P)     / 500M(A)
AV:    1330, FT/SEC                                AVERAGE POWER:     300, WATTS
LIFE: 3,0 YEARS                                    SIZE:  DIAMETER  5,0 FT,  LENGTH  7,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  1             DENSITY:  10,0 LBS/FT3

ACCEPTABLE MISSION MODES:
    ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                     ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
    ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                     ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )

  **LAUNCH SCHEDULE:  **          **YEAR**    79  80  81  82  83  84  85  86  87  88  89  90  91  92  93  94  95  96  97
NUMBER OF LAUNCHES                                                 1                       1
NEW UNITS (EXPENDABLE)                                             1                       1
NUMBER OF RETRIEVALS                                                           1
NEW UNITS + NOR INV (REUSEABLE)                                    1
EXPERIMENT R&D APPLICATION                                         *                       *
OPERATION INDEPENDENT COST APPLICATION                             *   *   *               *   *   *

** WEIGHTS & COSTS: **          **WEIGHT (LBS)**           **R&D COST ($M)**                        **UNIT COST ($M)**
                                 *B/L*   *L/C*     *BASELINE*          *LOW COST*          *BASELINE*          *LOW COST*
  **SUBSYSTEM**                                                     *NO RISK*  *RISK*                        *NO RISK*  *RISK*
ADAPTER                            50,    108,        ,627              ,501       ,501        ,138                 ,124      ,124
EXPERIMENT MISSION EQUIPMENT      350,    655,      34,649 (2,40)     28,569     26,569      3,515 (1,90)         2,915     2,498
STRUCTURES AND MECHANISMS         200,    947,       6,529 (1,36)      4,799      3,783       ,358                 ,649      ,649
ELECTRICAL POWER                  480,    824,      17,892 (1,75)     12,154     10,939      2,434                2,356     1,956
STABILITY & CONTROL               150,    259,      27,365            18,093     15,560      2,553                2,243     2,281
ATTITUDE CONTROL                   20,    104,       1,839             1,577      1,419       ,115                 ,197      ,187
PROPULSION                          0,      0,        ,003              ,000       ,000       ,000                 ,000      ,000
TRACKING & TELEMETRY              120,    218,      29,356            28,930     26,037      3,192                3,553     3,233
ENVIRONMENTAL CONTROL              50,     96,       2,757             2,165      1,949       ,510                 ,394      ,394
EXPENDABLE PROP, & GASSES          80,    181,        ,000              ,000       ,000       ,000                 ,000      ,000
    ** TOTAL **                  1500,   3392,     116,982            96,288     86,757      12,812               12,395    11,277

  MIN, INERT WT,      EXPENDABLE P/L  1420,     REFURB, INERT WT,          595,
  MIN, TOTAL WT,      EXPENDABLE P/L  1500,     REFURB, PROP, WT,           34,          *RISK SAVINGS ($M)* *REUSE,**EXPEND,*
                                                REFURB, L/C S/S WT,        628,               R&D EXPERIMENT     1,9998    ,7999
    REFURB, TOTAL WT, REUSEABLE P/L    628,     L/C SUBSYSTEMS WT,        3392,               TOTAL  R&D         9,5314   3,8125
  MIN, PROPELLANT WT, REUSEABLE P/L    114,     FIXED SUBSYSTEMS WT,         0,               TOTAL  UNIT        1,1178    ,6471
  MIN, INERT WT,      REUSEABLE P/L   2015,     FACTOR: (L/C=B/L+REF(L/C)) = 1283,52
  MIN, TOTAL WT,      REUSEABLE P/L   2128,     RATIO: INERT WT,/TOTAL WT, =  ,94667

    R&D PHASE: 4,0 YEARS     R&D SPREAD  50% TIME AT ,40 COST
    NEW EXPERIMENT R&D: YES     ( EVERY  1 LAUNCHES )

    OPERATING COST:  DEPENDENT $  1,860 MILLION/LAUNCH,  INDEPENDENT $  2,950 MILLION/YEAR

    FIXED PORTION INITIAL INVESTMENT: $   ,000 MILLION
    INVESTMENT PHASE: 3,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,90 COST                 P/L COST CONFIDENCE: POOR

    PERIGEE ALTITUDE:   300,00 N,M,                   APOGEE ALTITUDE:   300,00 N,M,
    INITIAL ORBIT INCLINATION:  90,00 DEGREES         TUG MISSION DURATION:     ,00 HOURS

    % RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,%   AND IN MODE 2 = 100,%
```

Table 5-6. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 5

MISSION FLEMING NUMBER: 6 SUBFIELD: 0 NAME: GRAVITY RELATIVITY EXPER •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NSP-7 •• (BASELINE & LOW COST) ••

INCLINATION: .00 DEGREES ORBIT: 1.0.A.U. / ESCAPE
ΔV: 12000. FT/SEC AVERAGE POWER: 300. WATTS
LIFE: 3.0 YEARS SIZE: DIAMETER 4.0 FT. LENGTH 5.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1 DENSITY: 0.0 LBS/FT3

ACCEPTABLE MISSION MODES:
•• NO •• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• NO •• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			1						1										
NEW UNITS (EXPENDABLE)			1						1										
EXPERIMENT R&D APPLICATION			•						•										
OPERATION INDEPENDENT COST APPLICATION			•	•	•				•	•	•								

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)••		••R&D COST ($M)••				••UNIT COST ($M)••			
	•B/L•	•L/C•	•BASELINE•		•LOW COST•		•BASELINE•		•LOW COST•	
••SUBSYSTEM••					•NO RISK•	•RISK•			•NO RISK•	•RISK•
ADAPTER	15.	42.	.339		.317	.317	.096		.078	.078
EXPERIMENT MISSION EQUIPMENT	120.	211.	24.075	(2.40)	19.010	17.680	1.792	(1.90)	1.425	1.300
STRUCTURES AND MECHANISMS	70.	435.	3.197	(1.36)	2.270	1.997	.176		.392	.382
ELECTRICAL POWER	120.	247.	8.149	(1.75)	6.144	5.529	1.356		1.435	1.191
STABILITY & CONTROL	25.	63.	4.763		4.541	3.935	.350		.463	.426
ATTITUDE CONTROL	30.	213.	2.250		2.290	2.061	.195		.327	.327
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	60.	90.	15.380		15.145	13.631	2.193		2.185	1.968
ENVIRONMENTAL CONTROL	10.	57.	.900		.765	.688	.115		.125	.125
EXPENDABLE PROP. & GASSES	50.	151.	.000		.000	.000	.000		.000	.000
•• TOTAL ••	500.	1509.	59.047		50.481	45.808	6.218		6.401	5.818

MIN. INERT WT. EXPENDABLE P/L 450. REFURB. INERT WT. 383.
MIN. TOTAL WT. EXPENDABLE P/L 500. REFURB. PROP. WT. 43.
REFURB. L/C S/S WT. 426.
REFURB. TOTAL WT. REUSEABLE P/L 426. L/C SUBSYSTEMS WT. 1509.
MIN. PROPELLANT WT. REUSEABLE P/L 93. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 833. FACTOR: (L/C-B/L-REF(L/C)) = 383.11
MIN. TOTAL WT. REUSEABLE P/L 926. RATIO: INERT WT./TOTAL WT. = .90000

•RISK SAVINGS ($M)•	•REUSE.•	•EXPEND.•
R&D EXPERIMENT	1.3307	.5323
TOTAL R&D	4.6731	1.8692
TOTAL UNIT	.5831	.2332

R&D PHASE: 3.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.000 MILLION/LAUNCH, INDEPENDENT $ 1.200 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST • CONFIDENCE: POOR

PERIGEE ALTITUDE: .00 N.M. APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-7. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 9

MISSION PLANNING NUMBER: 9   SUBFIELD: 8   NAME: RADIO INTERFEROMETER TEL   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NAS-11   ** (BASELINE & LOW COST) **

INCLINATION: 28.50 DEGREES   ORBIT: 38646N(P) / 38646N(A)
DV: 13680. FT/SEC   AVERAGE POWER: 300. WATTS
LIFE: 3.0 YEARS   SIZE: DIAMETER 14.0 FT, LENGTH 25.0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2   DENSITY: 1.5 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1)   ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2)   ** YES ** EXPENDABLE PAYLOAD (MODE 4)

**LAUNCH SCHEDULE: **	**YEAR** 79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			2																
NEW UNITS (EXPENDABLE)			3																
OPERATION INDEPENDENT COST APPLICATION			*	*	*														

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	200.	317.	1.133		.049	.048	.210		.145	.145
EXPERIMENT MISSION EQUIPMENT	2260.	4731.	29.098	(1.00)	24.257	22.512	11.780	(1.90)	10.391	9.612
STRUCTURES AND MECHANISMS	1160.	1806.	11.080	(1.36)	7.295	6.419	1.183		1.077	1.207
ELECTRICAL POWER	260.	484.	12.610	(1.79)	8.989	8.090	1.895		1.892	1.571
STABILITY & CONTROL	1160.	1313.	95.000		87.695	75.418	24.000		13.538	12.455
ATTITUDE CONTROL	120.	844.	4.600		4.665	4.199	.960		.949	.949
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	260.	361.	44.354		41.026	37.614	4.898		4.690	4.259
ENVIRONMENTAL CONTROL	290.	290.	13.557		13.550	12.195	2.670		2.670	2.070
EXPENDABLE PROP. & GASSES	290.	915.	.000		.000	.000	.000		.000	.000
** TOTAL **	6000.	10661.	211.424		189.075	167.325	47.576		35.273	32.068

MIN. INERT WT. EXPENDABLE P/L 5710.   REFURB. INERT WT. 1351.
MIN. TOTAL WT. EXPENDABLE P/L 6000.   REFURB. PROP. WT. 49.
REFURB. L/C S/S WT. 1381.
REFURB. TOTAL WT. REUSEABLE P/L 1420.   L/C SUBSYSTEMS WT. 10371.
MIN. PROPELLANT WT. REUSEABLE P/L 359.   FIXED SUBSYSTEMS WT. 290.
MIN. INERT WT. REUSEABLE P/L 7061.   FACTOR: (L/C-B/L-REF(L/C)) = 3270.86
MIN. TOTAL WT. REUSEABLE P/L 7420.   RATIO: INERT WT./TOTAL WT. = .09167

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.6949	.6778
TOTAL R&D	21.7902	8.7001
TOTAL UNIT	2.6053	1.0421

R&D PHASE: 6.0 YEARS   R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 5.750 MILLION/LAUNCH, INDEPENDENT $ 12.900 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 38646.00 N.M.   APOGEE ALTITUDE: 38646.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-8. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 10

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MISSION FLEMING NUMBER: 10      SUBFIELD: 0        NAME: SOLAR OBSERVATORY A              ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NAS-7                                                               ** (BASELINE & LOW COST)  **

INCLINATION: 30.00 DEGREES                         ORBIT: 19323N(P)   / 19323N(A)
DV:   12900. FT/SEC                                AVERAGE POWER:    200. WATTS
LIFE: 5.0 YEARS                                    SIZE:  DIAMETER 10.0 FT.  LENGTH 12.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  1             DENSITY:    2.0 LBS/FT3

ACCEPTABLE MISSION MODES:
    ** YES**    RETRIEVABLE PAYLOAD ( MODE 1 )                  ** YES**    EXPENDABLE PAYLOAD ( MODE 3 )
    ** YES**    RETRIEVABLE PAYLOAD ( MODE 2 )                  ** YES**    EXPENDABLE PAYLOAD ( MODE 4 )
```

**LAUNCH SCHEDULE: **	**YEAR** 79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES						1					1								
NEW UNITS (EXPENDABLE)						2					1								
NUMBER OF RETRIEVALS										1									
NEW UNITS + NON INV (REUSEABLE)						1													
EXPERIMENT R&D APPLICATION						*					*								
OPERATION INDEPENDENT COST APPLICATION						*	*	*	*	*	*	*	*	*	*				

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM										
ADAPTER	60.	125.	.675		.537	.537	.145		.129	.129
EXPERIMENT MISSION EQUIPMENT	750.	1469.	31.751	(1.00)	20.538	19.101	5.653	(1.90)	4.933	4.532
STRUCTURES AND MECHANISMS	300.	1145.	7.752	(1.30)	5.022	4.420	.471		.739	.739
ELECTRICAL POWER	220.	419.	11.557	(1.75)	8.279	7.451	1.740		1.783	1.499
STABILITY & CONTROL	150.	259.	35.329		23.358	20.088	2.553		2.243	2.261
ATTITUDE CONTROL	60.	495.	3.259		3.538	3.185	.423		.627	.627
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	150.	259.	38.571		42.393	38.154	3.600		3.934	3.552
ENVIRONMENTAL CONTROL	50.	96.	2.753		2.165	1.949	.510		.394	.394
EXPENDABLE PROP. & GASSES	140.	343.	.000		.000	.000	.000		.000	.000
** TOTAL **	1880.	4610.	131.629		105.831	94.883	15.106		14.695	13.494

```
MIN. INERT WT.      EXPENDABLE P/L  1740.      REFURB. INERT WT.         682.
MIN. TOTAL WT.      EXPENDABLE P/L  1880.      REFURB. PROP. WT.          55.     *RISK SAVINGS ($M)* *REUSE.* *EXPEND.*
                                               REFURB. L/C S/S WT.       737.          R&D EXPERIMENT    1.4377    .9791
   REFURB. TOTAL WT. REUSEABLE P/L   737.      L/C SUBSYSTEMS WT.       4610.          TOTAL  R&D       10.9481   4.3792
MIN. PROPELLANT WT. REUSEABLE P/L    195.      FIXED SUBSYSTEMS WT.        0.          TOTAL  UNIT       1.2010    .4804
MIN. INERT WT.      REUSEABLE P/L   2422.      FACTOR: (L/C=B/L=REF(L/C)) = 1993.23
MIN. TOTAL WT.      REUSEABLE P/L   2617.      RATIO: INERT WT./TOTAL WT. =  .92593

R&D PHASE: 4.5 YEARS     R&D SPREAD  50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES     ( EVERY  1 LAUNCHES )

OPERATING COST:  DEPENDENT $  2.180 MILLION/LAUNCH,   INDEPENDENT $  3.050 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $   .000 MILLION
INVESTMENT PHASE: 3.00 YEARS    INVESTMENT SPREAD: 50% TIME AT .50 COST                    P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 19323.00 N.M.                 APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION:  30.00 DEGREES       TUG MISSION DURATION:    .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
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Table 5-9. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 11

MISSION FLEMING NUMBER: 11   SUBFIELD: 0   NAME: SOLAR OBSERVATORY 8   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NAS-8   ** (BASELINE & LOW COST) **

INCLINATION: 28,50 DEGREES   ORBIT: 1,0 A.U. / CIRC.
ΔV: 11300. FT/SEC   AVERAGE POWER: 1500. WATTS
LIFE: 5,0 YEARS   SIZE: DIAMETER 10,0 FT, LENGTH 12,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 2,7 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1)   ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2)   ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES						1					1								
NEW UNITS (EXPENDABLE)						1					1								
EXPERIMENT R&D APPLICATION						•					•								
OPERATION INDEPENDENT COST APPLICATION						•	•	•	•	•	•	•	•	•	•				

** WEIGHTS & COSTS: ** **SUBSYSTEM**	WEIGHT (LBS) B/L	WEIGHT (LBS) L/C	R&D COST ($M) BASELINE	R&D COST ($M) LOW COST NO RISK	R&D COST ($M) LOW COST RISK	UNIT COST ($M) BASELINE	UNIT COST ($M) LOW COST NO RISK	UNIT COST ($M) LOW COST RISK
ADAPTER	80.	156.	,789	,599	,599	,159	,117	,117
EXPERIMENT MISSION EQUIPMENT	750.	1469.	31,751 (1,00)	20,539	19,101	5,650 (1,00)	4,900	4,532
STRUCTURES AND MECHANISMS	350.	1221.	8,228 (1,36)	5,291	4,656	,522	,772	,772
ELECTRICAL POWER	750.	1214.	24,000 (1,75)	15,147	13,626	2,925	2,764	2,294
STABILITY & CONTROL	150.	259.	35,329	23,359	20,088	2,550	2,240	2,261
ATTITUDE CONTROL	80.	643.	3,750	4,252	3,647	,600	,769	,769
PROPULSION	0.	0.	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	150.	259.	38,571	42,393	38,154	3,600	3,954	3,552
ENVIRONMENTAL CONTROL	50.	96.	2,750	2,165	1,969	,510	,394	,394
EXPENDABLE PROP. & GASSES	160.	360.	,000	,000	,000	,000	,000	,000
** TOTAL **	2520.	5677.	145,164	113,537	101,819	16,516	15,858	14,490

MIN. INERT WT. EXPENDABLE P/L 2360.   REFURB. INERT WT. 759.
MIN. TOTAL WT. EXPENDABLE P/L 2520.   REFURB. PROP. WT. 51.
REFURB. L/C S/S WT. 811.
REFURB. TOTAL WT. REUSEABLE P/L 811.   L/C SUBSYSTEMS WT. 5677.
MIN. PROPELLANT WT. REUSEABLE P/L 211.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 3119.   FACTOR: (L/C-B/L-REF(L/C)) = 2346.29
MIN. TOTAL WT. REUSEABLE P/L 3331.   RATIO: INERT WT./TOTAL WT. = .93651

RISK SAVINGS ($M)	REUSE.	EXPEND.
R&D EXPERIMENT	1,4377	,5751
TOTAL R&D	11,7174	4,6871
TOTAL UNIT	1,3679	,5471

R&D PHASE: 4,5 YEARS   R&D SPREAD 50% TIME AT ,20 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 2,310 MILLION/LAUNCH, INDEPENDENT $ 3,400 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,50 COST   P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: ,00 N.M.   APOGEE ALTITUDE: ,00 N.M.
INITIAL ORBIT INCLINATION: 28,50 DEGREES   TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-10. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 12

MISSION FLEMING NUMBER: 12 SUBFIELD: 0 NAME: OPTICAL INTERFEROMETER ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NAS910 ** (BASELINE & LOW COST) **

INCLINATION: 28.50 DEGREES
ΔV: 12950. FT/SEC
LIFE: 5.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2

ORBIT: 19323N(P) / 19323N(A)
AVERAGE POWER: 230. WATTS
SIZE: DIAMETER 7.0 FT, LENGTH 10.0 FT.
DENSITY: 8.2 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1) ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2) ** YES ** EXPENDABLE PAYLOAD (MODE 4)

**LAUNCH SCHEDULE: **	**YEAR** 79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES										2									
NEW UNITS (EXPENDABLE)										5									
OPERATION INDEPENDENT COST APPLICATION										*	*	*	*	*					

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	130.	227.	1.000	.720	.720	.142	.131	.131
EXPERIMENT MISSION EQUIPMENT	750.	1469.	31.751 (1.00)	20.538	19.101	5.650 (1.90)	4.900	4.532
STRUCTURES AND MECHANISMS	600.	1484.	9.654 (1.36)	6.210	5.465	.753	.881	.881
ELECTRICAL POWER	310.	564.	14.135 (1.75)	9.831	8.821	2.015	2.015	1.873
STABILITY & CONTROL	500.	674.	114.036	59.141	50.862	9.500	6.458	5.942
ATTITUDE CONTROL	100.	759.	4.209	4.416	3.975	.755	.875	.875
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	250.	353.	55.900	55.202	47.882	4.750	4.628	4.212
ENVIRONMENTAL CONTROL	300.	300.	14.000	14.000	12.600	2.750	2.750	2.750
EXPENDABLE PROP. & GASSES	200.	397.	.000	.000	.000	.000	.000	.000
** TOTAL **	3140.	6227.	244.645	168.030	149.425	26.375	22.638	20.995

MIN. INERT WT. EXPENDABLE P/L 2940.
MIN. TOTAL WT. EXPENDABLE P/L 3140.

REFURB. TOTAL WT. REUSEABLE P/L 990.
MIN. PROPELLANT WT. REUSEABLE P/L 263.
MIN. INERT WT. REUSEABLE P/L 3867.
MIN. TOTAL WT. REUSEABLE P/L 4130.

REFURB. INERT WT. 927.
REFURB. PROP. WT. 63.
REFURB. L/C S/S WT. 942.
L/C SUBSYSTEMS WT. 5927.
FIXED SUBSYSTEMS WT. 350.
FACTOR: (L/C-B/L)REF(L/C)) = 2145.01
RATIO: INERT WT./TOTAL WT. = .93631

RISK SAVINGS ($M) *REUSE.* *EXPEND.*
R&D EXPERIMENT 1.4377 .5751
TOTAL R&D 18.6347 7.4419
TOTAL UNIT 1.6433 .6573

R&D PHASE: 6.5 YEARS R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 3.900 MILLION/LAUNCH, INDEPENDENT $ 6.800 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.50 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-11. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 21

MISSION FLEMING NUMBER: 21 SUBFIELD: 0 NAME: POLAR EARTH OBSERVATION •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NEO-2 •• (BASELINE & LOW COST) ••

INCLINATION: 99.15 DEGREES ORBIT: 500N(P) / 500N(A)
ΔV: 1395. FT/SEC AVERAGE POWER: 1000. WATTS
LIFE: 2.0 YEARS SIZE: DIAMETER 6.0 FT. LENGTH 12.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2 DENSITY: 7.6 LBS/FT3

ACCEPTABLE MISSION MODES:
•• YES•• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• YES•• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1	1	1							
NUMBER OF RETRIEVALS			1	1	1	1	1	1	1	1	1								
NEW UNITS • N-R INV (REUSEABLE)	1	1	1																
EXPERIMENT R&D APPLICATION	•			•			•			•									
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•						

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)•• •B/L•	•L/C•	••R&D COST ($M)•• •BASELINE•	•LOW COST• •NO RISK•	•RISK•	••UNIT COST ($M)•• •BASELINE•	•LOW COST• •NO RISK•	•RISK•
••SUBSYSTEM••								
ADAPTER	90,	171,	,840	,626	,626	,149	,123	,123
EXPERIMENT MISSION EQUIPMENT	850,	1678,	38,460 (2,40)	32,696	30,407	6,270 (1,90)	5,336	4,936
STRUCTURES AND MECHANISMS	370,	1248,	12,400 (2,00)	7,923	6,972	,544	,783	,783
ELECTRICAL POWER	600,	1000,	20,400 (1,75)	13,565	12,209	2,652	2,552	2,118
STABILITY & CONTROL	200,	326,	29,553	18,445	15,843	3,500	2,885	2,654
ATTITUDE CONTROL	80,	643,	3,750	4,952	3,647	,600	,769	,769
PROPULSION	0,	0,	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	180,	293,	27,743	29,318	26,386	3,960	4,174	3,798
ENVIRONMENTAL CONTROL	60,	101,	3,200	2,379	2,137	,610	,434	,434
EXPENDABLE PROP. & GASSES	160,	359,	,000	,000	,000	,000	,000	,000
•• TOTAL ••	2590,	5819,	136,346	109,000	98,247	18,301	17,053	15,615

MIN. INERT WT. EXPENDABLE P/L 2430. REFURB. INERT WT. 774.
MIN. TOTAL WT. EXPENDABLE P/L 2590. REFURB. PROP. WT. 51.
REFURB. L/C S/S WT. 825.
REFURB. TOTAL WT. REUSEABLE P/L 825. L/C SUBSYSTEMS WT. 5819.
MIN. PROPELLANT WT. REUSEABLE P/L 211. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 3204. FACTOR: (L/C-B/L-REF(L/C)) = 2403.29
MIN. TOTAL WT. REUSEABLE P/L 3415. RATIO: INERT WT./TOTAL WT. = .93822

•RISK SAVINGS ($M)• •REUSE.• •EXPEND.•
R&D EXPERIMENT 2.2487 .9155
TOTAL R&D 10.7527 4.3011
TOTAL UNIT 1.4409 .5762

R&D PHASE: 5.0 YEARS R&D SPREAD: 50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES (EVERY 3 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.500 MILLION/LAUNCH, INDEPENDENT $ 4.680 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 500.00 N.M. APOGEE ALTITUDE: 500.00 N.M.
INITIAL ORBIT INCLINATION: 99.15 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-12. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 22

MISSION FLEMING NUMBER: 22 SUBFIELD: 0 NAME: SYNC, EARTH OBSERVATION ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEC-3 ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES ORBIT: 19323N(P) / 19323N(A)
ΔV: 14100. FT/SEC AVERAGE POWER: 400. WATTS
LIFE: 2.0 YEARS SIZE: DIAMETER 4.0 FT, LENGTH 6.0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1 DENSITY: 13.7 LBS/FT3

ACCEPTABLE MISSION MODES;
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		1		1		1		1		1		1							
NEW UNITS (EXPENDABLE)		1		1		1		1		1		1							
NUMBER OF RETRIEVALS				1		1		1		1									
NEW UNITS + N.R INV (REUSEABLE)		1		1															
EXPERIMENT R&D APPLICATION		•		•		•		•		•		•							
OPERATION INDEPENDENT COST APPLICATION		•	•	•	•	•	•	•	•	•	•	•	•						

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	30.	73.	.480		.412	.412	.118		.093	.093
EXPERIMENT MISSION EQUIPMENT	350.	655.	28.263	(2.40)	23.327	21.694	3.515	(1.90)	2.915	2.596
STRUCTURES AND MECHANISMS	150.	807.	5.712	(1.36)	3.769	3.316	.298		.582	.582
ELECTRICAL POWER	200.	385.	10.900	(1.75)	7.900	7.110	1.690		1.723	1.430
STABILITY & CONTROL	65.	134.	9.898		7.749	6.664	1.030		1.074	.988
ATTITUDE CONTROL	40.	315.	2.830		2.802	2.522	.260		.442	.442
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	95.	175.	17.463		20.102	18.091	2.893		3.145	2.862
ENVIRONMENTAL CONTROL	20.	71.	1.400		1.280	1.152	.215		.224	.724
EXPENDABLE PROP. & GASSES	80.	220.	.000		.000	.000	.000		.000	.000
** TOTAL **	1030.	2835.	76.763		67.340	60.961	9.899		10.197	9.317

MIN. INERT WT. EXPENDABLE P/L 950. REFURB. INERT WT. 514.
MIN. TOTAL WT. EXPENDABLE P/L 1030. REFURB. PROP. WT. 43.
REFURB. L/C S/S WT. 557.
REFURB. TOTAL WT. REUSEABLE P/L 557. L/C SUBSYSTEMS WT. 2835.
MIN. PROPELLANT WT. REUSEABLE P/L 123. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1464. FACTOR: (L/C-B/L+REF(L/C)) = 1247.78
MIN. TOTAL WT. REUSEABLE P/L 1587. RATIO: INERT WT./TOTAL WT. = .92233

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.6329	.6531
TOTAL R&D	6.3783	2.5513
TOTAL UNIT	.8804	.3522

R&D PHASE: 3.5 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.920 MILLION/LAUNCH, INDEPENDENT $ 1.980 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-13. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 23

MISSION FLEMING NUMBER: 23 SUBFIELD: 0 NAME: EARTH PHYSICS SAT. ** MISSION / PAYLOAD DATA ** ** (BASELINE & LOW COST) **
MISSION CODE NUMBER: NEO-5

INCLINATION: 90.00 DEGREES ORBIT: 400N(P) / 400N(A)
ΔV: 1200. FT/SEC AVERAGE POWER: 200. WATTS
LIFE: 2.0 YEARS SIZE: DIAMETER 3.5 FT. LENGTH 6.5 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1 DENSITY: 9.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		1	1	1	1		1		1		1								
NEW UNITS (EXPENDABLE)		1	1	1	1		1		1		1								
NUMBER OF RETRIEVALS				1	1		1		1										
NEW UNITS + N-R INV (REUSEABLE)		1	1	1															
EXPERIMENT R&D APPLICATION		*					*												
OPERATION INDEPENDENT COST APPLICATION		*	*	*	*	*	*	*	*	*	*	*							

** WEIGHTS & COSTS: **

SUBSYSTEM	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	20.	53.	.390		.353	.353	.104		.084	.084
EXPERIMENT MISSION EQUIPMENT	150.	267.	21.210	(2.40)	16.897	15.715	2.050	(1.90)	1.636	1.513
STRUCTURES AND MECHANISMS	80.	500.	3.672	(1.36)	2.545	2.240	.192		.421	.421
ELECTRICAL POWER	170.	335.	9.945	(1.75)	7.292	6.563	1.591		1.626	1.349
STABILITY & CONTROL	30.	72.	4.664		4.267	3.670	.420		.544	.500
ATTITUDE CONTROL	30.	213.	2.259		2.290	2.061	.185		.327	.327
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	60.	90.	12.554		12.366	11.130	2.190		2.185	1.988
ENVIRONMENTAL CONTROL	10.	57.	.900		.765	.688	.115		.125	.125
EXPENDABLE PROP. & GASSES	50.	144.	.000		.000	.000	.000		.000	.000
** TOTAL **	600.	1731.	55.589		46.776	42.419	6.837		6.946	6.307

MIN. INERT WT. EXPENDABLE P/L 550. REFURB. INERT WT. 409.
MIN. TOTAL WT. EXPENDABLE P/L 600. REFURB. PROP. WT. 37.
REFURB. L/C S/S WT. 446.
REFURB. TOTAL WT. REUSEABLE P/L 446. L/C SUBSYSTEMS WT. 1731.
MIN. PROPELLANT WT. REUSEABLE P/L 87. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 959. FACTOR: (L/C-B/L-REF(L/C)) = 685.07
MIN. TOTAL WT. REUSEABLE P/L 1046. RATIO: INERT WT./TOTAL WT. = .91667

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.1829	.4731
TOTAL R&D	4.3573	1.7428
TOTAL UNIT	.6392	.2557

R&D PHASE: 3.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 4 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.100 MILLION/LAUNCH, INDEPENDENT $ 1.350 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION P/L COST CONFIDENCE: FAIR
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST

PERIGEE ALTITUDE: 400.00 N.M. APOGEE ALTITUDE: 400.00 N.M.
INITIAL ORBIT INCLINATION: 90.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 4 = 100.%

Table 5-14. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 24

MISSION FLEMING NUMBER: 24   SUBFIELD: 0   NAME: SYNC, METEOROLOGICAL SAT   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEO-8   ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES   ORBIT: SYNC.H(P) / SYNC.H(A)
AV: 14100. FT/SEC   AVERAGE POWER: 300. WATTS
LIFE: 2.0 YEARS   SIZE: DIAMETER 5.0 FT, LENGTH 8.0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 6.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES				1	1														
NEW UNITS (EXPENDABLE)				1	1														
OPERATION INDEPENDENT COST APPLICATION				*	*	*													

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	35.	82.	.520	.437	.437	.124	.096	.096
EXPERIMENT MISSION EQUIPMENT	250.	459.	25.310 (2.40)	20.523	19.087	2.850 (1.90)	2.317	2.143
STRUCTURES AND MECHANISMS	160.	839.	5.848 (1.36)	3.869	3.422	.307	.598	.598
ELECTRICAL POWER	250.	468.	12.400 (1.79)	8.817	7.935	1.850	1.866	1.549
STABILITY & CONTROL	70.	142.	10.676	8.205	7.056	1.090	1.146	1.094
ATTITUDE CONTROL	50.	409.	2.950	3.204	2.885	.340	.541	.541
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	100.	184.	18.241	20.893	18.803	2.840	3.238	2.946
ENVIRONMENTAL CONTROL	30.	81.	1.850	1.640	1.476	.320	.293	.293
EXPENDABLE PROP. & GASSES	90.	254.	.000	.000	.000	.000	.000	.000
** TOTAL **	1035.	2916.	77.795	67.609	61.102	9.761	10.094	9.220

MIN. INERT WT. EXPENDABLE P/L 945.   REFURB. INERT WT. 519.
MIN. TOTAL WT. EXPENDABLE P/L 1035.   REFURB. PROP. WT. 49.
REFURB. L/C S/S WT. 569.
REFURB. TOTAL WT. REUSEABLE P/L 569.   L/C SUBSYSTEMS WT. 2916.
MIN. PROPELLANT WT. REUSEABLE P/L 139.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1464.   FACTOR: (L/C-B/L-REF(L/C)) = 1312.22
MIN. TOTAL WT. REUSEABLE P/L 1604.   RATIO: INERT WT./TOTAL WT. = .91304

RISK SAVINGS ($M)	*REUSE.*	**EXPEND.*
R&D EXPERIMENT	1.4366	.5746
TOTAL R&D	6.5075	2.6030
TOTAL UNIT	.8741	.3496

R&D PHASE: 3.5 YEARS   R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.500 MILLION/LAUNCH, INDEPENDENT $ 1.960 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M.   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-15. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 25

MISSION FLEMING NUMBER: 25   SUBFIELD: 0   NAME: TIROS-D   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEO-6   ** (BASELINE & LOW COST) **

INCLINATION:100,70 DEGREES   ORBIT: 700N(P) / 700N(A)
ΔV: 1900, FT/SEC   AVERAGE POWER: 200, WATTS
LIFE: 5,0 YEARS   SIZE: DIAMETER 5,0 FT, LENGTH 10,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 9,3 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			1				1					1							
NEW UNITS (EXPENDABLE)			1				1					1							
NUMBER OF RETRIEVALS							1												
NEW UNITS - N-R INV (REUSEABLE)			1																
NEW UNITS - REC INV (REUSEABLE)							1												
EXPERIMENT R&D APPLICATION			•				•					•							
OPERATION INDEPENDENT COST APPLICATION			•	•	•	•	•	•	•	•	•	•	•	•	•	•			

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	30,	73,	,000	,000	,000	,118	,093	,093
EXPERIMENT MISSION EQUIPMENT	245,	449,	39,803 (2,40)	32,201	29,947	2,753 (1,90)	2,286	2,114
STRUCTURES AND MECHANISMS	200,	947,	,003 (,00)	,000	,000	,358	,649	,649
ELECTRICAL POWER	270,	500,	,000 (,00)	,000	,000	1,917	1,918	1,592
STABILITY & CONTROL	65,	134,	,000	,000	,000	1,000	1,074	,988
ATTITUDE CONTROL	30,	213,	,000	,000	,000	,155	,327	,327
PROPULSION	0,	0,	,003	,000	,000	,003	,030	,000
TRACKING & TELEMETRY	93,	165,	,000	,000	,000	2,745	3,045	2,771
ENVIRONMENTAL CONTROL	20,	71,	,000	,000	,000	,215	,224	,224
EXPENDABLE PROP, & GASSES	80,	219,	,000	,000	,000	,000	,000	,000
** TOTAL **	1030,	2767,	39,803	32,201	29,947	9,288	9,615	8,758

MIN, INERT WT, EXPENDABLE P/L 950,   REFURB, INERT WT, 539,
MIN, TOTAL WT, EXPENDABLE P/L 1030,   REFURB, PROP, WT, 45,
REFURB, L/C S/S WT, 584,
REFURB, TOTAL WT, REUSEABLE P/L 584,   L/C SUBSYSTEMS WT, 2767,
MIN, PROPELLANT WT, REUSEABLE P/L 125,   FIXED SUBSYSTEMS WT, 0,
MIN, INERT WT, REUSEABLE P/L 1489,   FACTOR: (L/C-B/L-REF(L/C)) = 1152,60
MIN, TOTAL WT, REUSEABLE P/L 1614,   RATIO: INERT WT,/TOTAL WT, = ,92233

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	2,2541	,9016
TOTAL R&D	2,2541	,9016
TOTAL UNIT	,8574	,3430

R&D PHASE: 3,0 YEARS   R&D SPREAD 50% TIME AT ,40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,430 MILLION/LAUNCH, INDEPENDENT $ 1,850 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 2,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,50 COST   P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 700,00 N,M,   APOGEE ALTITUDE: 700,00 N,M,
INITIAL ORBIT INCLINATION: 100,70 DEGREES   TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-16. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 26

MISSION FLEWING NUMBER: 26 SUBFIELD: 0 NAME: POLAR EARTH RES. SAT. ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEC-16 ** (BASELINE & LOW COST) **

INCLINATION: 99.15 DEGREES ORBIT: 500M(P) / 500M(A)
ΔV: 1330. FT/SEC AVERAGE POWER: 600. WATTS
LIFE: 2.0 YEARS SIZE: DIAMETER 6.0 FT, LENGTH 12.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 4 DENSITY: 7.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

**LAUNCH SCHEDULE: **	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES								2	4										
NEW UNITS (EXPENDABLE)								2	4										
OPERATION INDEPENDENT COST APPLICATION								*	*	*									

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	90.	171.	.000	.000	.000	.165	.120	.120
EXPERIMENT MISSION EQUIPMENT	850.	1678.	38.463 (2.40)	32.696	30.407	6.273 (1.90)	5.336	4.936
STRUCTURES AND MECHANISMS	370.	1248.	12.400 (2.00)	7.923	6.972	.544	.783	.783
ELECTRICAL POWER	600.	1000.	20.400 (1.75)	13.565	12.209	2.652	2.552	2.118
STABILITY & CONTROL	230.	326.	.000	.000	.000	3.500	2.855	2.654
ATTITUDE CONTROL	80.	643.	.000	.000	.000	.600	.769	.769
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	180.	293.	.000	.000	.000	3.960	4.174	3.798
ENVIRONMENTAL CONTROL	60.	101.	.000	.000	.000	.610	.434	.434
EXPENDABLE PROP. & GASSES	160.	359.	.000	.000	.000	.000	.000	.000
** TOTAL **	2590.	5819.	71.263	54.184	49.588	18.301	17.053	15.613

MIN. INERT WT. EXPENDABLE P/L 2430. REFURB. INERT WT. 774.
MIN. TOTAL WT. EXPENDABLE P/L 2590. REFURB. PROP. WT. 51.
REFURB. L/C S/S WT. 825.
REFURB. TOTAL WT. REUSEABLE P/L 825. L/C SUBSYSTEMS WT. 5819.
MIN. PROPELLANT WT. REUSEABLE P/L 211. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 3204. FACTOR: (L/C-B/L-REF(L/C)) = 2405.29
MIN. TOTAL WT. REUSEABLE P/L 3415. RATIO: INERT WT./TOTAL WT. = .93822

RISK SAVINGS ($M) *REUSE.* *EXPEND.*
R&D EXPERIMENT 2.2887 .9155
TOTAL R&D 4.5963 1.8384
TOTAL UNIT 1.4405 .5762

R&D PHASE: 4.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.500 MILLION/LAUNCH, INDEPENDENT $ 6.080 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 500.00 N.M. APOGEE ALTITUDE: 500.00 N.M.
INITIAL ORBIT INCLINATION: 99.15 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-17. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 27

MISSION FLEMING NUMBER: 27 SUBFIELD: 0 NAME: SYNC. EARTH RES. SAT. ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NE0-4 ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES ORBIT: SYNCH(P) / SYNCH(A)
DV: 14100. FT/SEC AVERAGE POWER: 400. WATTS
LIFE: 2.0 YEARS SIZE: DIAMETER 4.0 FT. LENGTH 6.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2 DENSITY: 13.7 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			1	2	1				1	2									
NEW UNITS (EXPENDABLE)			1	2	1				1	2									
NUMBER OF RETRIEVALS				1	1	1			1										
NEW UNITS + NON INV (REUSEABLE)			1	2															
EXPERIMENT R&D APPLICATION			*							*									
OPERATION INDEPENDENT COST APPLICATION			*	*	*	*			*	*	*								

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	30.	73.	.000	.000	.000	.118	.093	.093
EXPERIMENT MISSION EQUIPMENT	350.	655.	28.280 (2.40)	23.327	21.694	3.515 (1.90)	2.915	2.696
STRUCTURES AND MECHANISMS	150.	807.	8.400 (2.00)	5.542	4.877	.278	.582	.582
ELECTRICAL POWER	200.	385.	10.900 (1.75)	7.900	7.110	1.690	1.723	1.430
STABILITY & CONTROL	65.	134.	.000	.000	.000	1.000	1.074	.988
ATTITUDE CONTROL	40.	319.	.000	.000	.000	.240	.442	.442
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	95.	175.	.000	.000	.000	2.803	3.145	2.862
ENVIRONMENTAL CONTROL	20.	71.	.000	.000	.000	.215	.224	.224
EXPENDABLE PROP. & GASSES	80.	220.	.000	.000	.000	.000	.000	.000
** TOTAL **	1030.	2835.	47.580	36.768	33.680	9.899	10.197	9.317

MIN. INERT WT. EXPENDABLE P/L 950. REFURB. INERT WT. 514.
MIN. TOTAL WT. EXPENDABLE P/L 1030. REFURB. PROP. WT. 43.
REFURB. L/C S/S WT. 557.
REFURB. TOTAL WT. REUSEABLE P/L 557. L/C SUBSYSTEMS WT. 2835.
MIN. PROPELLANT WT. REUSEABLE P/L 123. FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1464. FACTOR: (L/C-B/L-REF(L/C)) = 1247.78
MIN. TOTAL WT. REUSEABLE P/L 1587. RATIO: INERT WT./TOTAL WT. = .92233

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.6329	.6531
TOTAL R&D	3.0879	1.2351
TOTAL UNIT	.8804	.3522

R&D PHASE: 3.3 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 5 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.320 MILLION/LAUNCH. INDEPENDENT $ 2.505 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-18. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 28

MISSION FLEMING NUMBER: 28 SUBFIELD: 0 NAME: APPLIC. TECHNOLOGY SAT. ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-1 ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES ORBIT: SYNC.H(P) / SYNC.H(A)
ΔV: 14108. FT/SEC AVERAGE POWER: 8000. WATTS
LIFE: 5.0 YEARS SIZE: DIAMETER 15.0 FT. LENGTH 21.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2 DENSITY: 2.2 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1		1		1	1		1		1	1								
NEW UNITS (EXPENDABLE)	1		1		1	1		1		1	1								
NUMBER OF RETRIEVALS						1		1		1									
NEW UNITS - N-R INV (REUSEABLE)	1		1		1														
NEW UNITS - REC INV (REUSEABLE)						1													
EXPERIMENT R&D APPLICATION	•				•			•			•								
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	280.	411.	1.480		.964	.964	.232		.157	.157
EXPERIMENT MISSION EQUIPMENT	1600.	3281.	48.969	(1.25)	34.253	31.855	6.603	(1.35)	5.835	5.397
STRUCTURES AND MECHANISMS	1200.	1822.	16.300	(2.00)	10.808	9.511	1.203		1.013	1.013
ELECTRICAL POWER	2900.	3926.	49.735	(1.75)	29.457	26.511	5.148		4.493	3.721
STABILITY & CONTROL	1000.	1167.	102.000		100.963	86.828	20.500		11.891	10.931
ATTITUDE CONTROL	150.	913.	5.150		4.856	4.371	1.293		1.028	1.028
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	400.	443.	78.707		62.475	56.228	6.200		5.221	4.751
ENVIRONMENTAL CONTROL	300.	300.	14.000		14.000	12.600	2.750		2.750	2.753
EXPENDABLE PROP. & GASSES	400.	626.	.000		.000	.000	.000		.000	.000
** TOTAL **	8230.	12887.	316.340		257.777	228.868	43.910		32.349	29.729

MIN. INERT WT. EXPENDABLE P/L 7830. REFURB. INERT WT. 1453.
MIN. TOTAL WT. EXPENDABLE P/L 8230. REFURB. PROP. WT. 74.
REFURB. L/C S/S WT. 1492.
REFURB. TOTAL WT. REUSEABLE P/L 1527. L/C SUBSYSTEMS WT. 12587.
MIN. PROPELLANT WT. REUSEABLE P/L 474. FIXED SUBSYSTEMS WT. 300.
MIN. INERT WT. REUSEABLE P/L 9283. FACTOR: (L/C-B/L-REF(L/C)) = 3169.18
MIN. TOTAL WT. REUSEABLE P/L 9757. RATIO: INERT WT./TOTAL WT. = .95140

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	2.3977	.0591
TOTAL R&D	28.9284	11.5633
TOTAL UNIT	2.6201	1.0480

R&D PHASE: 6.0 YEARS R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES (EVERY 2 LAUNCHES)

OPERATING COST: DEPENDENT $ 5.400 MILLION/LAUNCH, INDEPENDENT $ 11.700 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-19. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 29

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MISSION FLEMING NUMBER: 29     SUBFIELD: 0      NAME: SMALL APPLIC TECH SAT A          ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-2A                                                             ** (BASELINE & LOW COST)   **

INCLINATION:   .00 DEGREES                      ORBIT: SYNCH(P)     / SYNCH(A)
DV:  14100. FT/SEC                              AVERAGE POWER:   500. WATTS
LIFE: 1.0 YEARS                                 SIZE:  DIAMETER  6.5 FT.  LENGTH 12.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  1          DENSITY:   1.8 LBS/FT3

ACCEPTABLE MISSION MODES:
   ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                   ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
   ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                   ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )
```

**LAUNCH SCHEDULE: *	**YEAR** 79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1	1	1							
NUMBER OF RETRIEVALS		1	1	1	1	1	1	1	1	1	1								
NEW UNITS - NON INV (REUSEABLE)	1	1																	
EXPERIMENT R&D APPLICATION	*	*	*	*	*	*	*	*	*	*	*	*							
OPERATION INDEPENDENT COST APPLICATION	*	*	*	*	*	*	*	*	*	*	*	*							

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	20.	53.	.393	.353	.353	.124	.094	.084
EXPERIMENT MISSION EQUIPMENT	150.	287.	8.133 (1.00)	4.979	4.630	2.030 (1.90)	1.635	1.513
STRUCTURES AND MECHANISMS	115.	677.	4.763 (1.36)	3.264	3.872	.247	.517	.517
ELECTRICAL POWER	150.	300.	5.325 (1.00)	3.918	3.526	1.520	1.554	1.293
STABILITY & CONTROL	25.	63.	2.753	2.421	2.254	.350	.443	.425
ATTITUDE CONTROL	30.	213.	2.253	2.290	2.061	.185	.327	.327
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	60.	90.	8.883	8.744	7.870	2.153	2.145	1.988
ENVIRONMENTAL CONTROL	10.	57.	.903	.765	.686	.115	.125	.125
EXPENDABLE PROP. & GASSES	60.	184.	.003	.000	.000	.003	.000	.000
** TOTAL **	620.	1904.	33.355	26.934	24.293	6.741	6.891	6.270

```
MIN. INERT WT.        EXPENDABLE P/L   560.     REFURB. INERT WT.          430.
MIN. TOTAL WT.        EXPENDABLE P/L   620.     REFURB. PROP. WT.           46.     *RISK SAVINGS ($M)* *REUSE,**EXPEND.*
                                                REFURB. L/C S/S WT.        477.          R&D EXPERIMENT       .3489     .1394
REFURB. TOTAL WT. REUSEABLE P/L        477.     L/C SUBSYSTEMS WT.        1904.          TOTAL  R&D          2.6789    1.0715
MIN. PROPELLANT WT. REUSEABLE P/L      106.     FIXED SUBSYSTEMS WT.         0.          TOTAL  UNIT          .6206     .2483
MIN. INERT WT.        REUSEABLE P/L    990.     FACTOR: (L/C-B/L-REF(L/C)) =  807.77
MIN. TOTAL WT.        REUSEABLE P/L   1097.     RATIO: INERT WT./TOTAL WT. =  .90323

R&D PHASE: 2.5 YEARS      R&D SPREAD  30% TIME AT .40 COST
NEW EXPERIMENT R&D: YES      ( EVERY  1 LAUNCHES )

OPERATING COST:  DEPENDENT $  1.090 MILLION/LAUNCH,  INDEPENDENT $  1.330 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $   .000 MILLION
INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST                  P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 19323.00 N.M.                   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION:  28.50 DEGREES         TUG MISSION DURATION:     .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
```

Table 5-20. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 30

MISSION FLEMING NUMBER: 30 SUBFIELD: 8 NAME: SMALL APPLIC TECH SAT B ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCA-28 ** (BASELINE & LOW COST) **

INCLINATION: 90.00 DEGREES
ΔV: 3809. FT/SEC
LIFE: 1.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1

ORBIT: 300M(P) / 3000M(A)
AVERAGE POWER: 500. WATTS
SIZE: DIAMETER 6.5 FT. LENGTH 12.0 FT.
DENSITY: 1.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES ** RETRIEVABLE PAYLOAD (MODE 1) ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** YES ** RETRIEVABLE PAYLOAD (MODE 2) ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1	1	1							
NUMBER OF RETRIEVALS		1	1	1	1	1	1	1	1	1	1								
NEW UNITS + N&R INV (REUSEABLE)	1	1																	
EXPERIMENT R&D APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•							
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•							

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**		**R&D COST ($M)**			**UNIT COST ($M)**		
	B/L	*L/C*	*BASELINE*	*LOW COST*		*BASELINE*	*LOW COST*	
SUBSYSTEM				*NO RISK*	*RISK*		*NO RISK*	*RISK*
ADAPTER	20.	53.	.390	.353	.353	.124	.044	.034
EXPERIMENT MISSION EQUIPMENT	150.	247.	15.300 (2.40)	11.948	11.112	2.050 (1.90)	1.636	1.513
STRUCTURES AND MECHANISMS	115.	677.	4.760 (1.36)	3.764	2.872	.247	.517	.517
ELECTRICAL POWER	150.	300.	9.319 (1.79)	6.857	6.171	1.500	1.554	1.290
STABILITY & CONTROL	25.	63.	2.759	2.621	2.254	.350	.443	.426
ATTITUDE CONTROL	30.	213.	2.250	2.290	2.061	.185	.327	.327
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	60.	90.	8.683	8.744	7.870	2.190	2.185	1.988
ENVIRONMENTAL CONTROL	10.	57.	.900	.765	.688	.115	.125	.125
EXPENDABLE PROP. & GASSES	60.	184.	.000	.000	.000	.030	.000	.000
** TOTAL **	620.	1904.	44.249	36.843	33.362	6.741	6.091	6.270

MIN. INERT WT. EXPENDABLE P/L 550.
MIN. TOTAL WT. EXPENDABLE P/L 620.

REFURB. TOTAL WT. REUSEABLE P/L 477.
MIN. PROPELLANT WT. REUSEABLE P/L 106.
MIN. INERT WT. REUSEABLE P/L 990.
MIN. TOTAL WT. REUSEABLE P/L 1097.

REFURB. INERT WT. 430.
REFURB. PROP. WT. 46.
REFURB. L/C S/S WT. 477.
L/C SUBSYSTEMS WT. 1904.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C+B/L-REF(L/C)) = 807.77
RATIO: INERT WT./TOTAL WT. = .90323

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.8364	.3346
TOTAL R&D	3.4606	1.3842
TOTAL UNIT	.6208	.2483

R&D PHASE: 3.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.090 MILLION/LAUNCH. INDEPENDENT $ 1.330 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .90 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 300.00 N.M. APOGEE ALTITUDE: 3000.00 N.M.
INITIAL ORBIT INCLINATION: 90.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-21. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 31

MISSION FLEMING NUMBER: 31   SUBFIELD: 0   NAME: COLP APPLICATION SAT A   ** MISSION / PAYLOAD - 4 **
MISSION CODE NUMBER: NCN-3A   ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES   ORBIT: SYNCH(P) / SYNCH(A)
ΔV: 14100. FT/SEC   AVERAGE POWER: 420. WATTS
LIFE: 2,3 YEARS   SIZE: DIAMETER 6,5 FT, LENGTH 12,0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 2,1 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1						1												
NEW UNITS (EXPENDABLE)	1						1												
NUMBER OF RETRIEVALS			1																
NEW UNITS + R&D INV (REUSEABLE)	1																		
EXPERIMENT R&D APPLICATION	*						*												
OPERATION INDEPENDENT COST APPLICATION	*	*					*	*											

** WEIGHTS & COSTS: **

SUBSYSTEM	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	30.	73.	.483	.412	.412	.115	.093	.093
EXPERIMENT MISSION EQUIPMENT	250.	459.	15,908 (1.25)	10,689	9,941	2,013 (1.35)	1,646	1,523
STRUCTURES AND MECHANISMS	120.	698.	4,937 (1.36)	3,346	2,944	.352	.528	.528
ELECTRICAL POWER	200.	385.	10,902 (1.75)	7,903	7,110	1,692	1,723	1,430
STABILITY & CONTROL	50.	109.	7,634	6,329	5,443	.790	.852	.784
ATTITUDE CONTROL	40.	315.	2,033	2,802	2,522	.290	.442	.442
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	80.	143.	15,497	7,362	15,626	2,563	2,018	2,564
ENVIRONMENTAL CONTROL	20.	71.	1,403	1,280	1,152	.215	.224	.224
EXPENDABLE PROP. & GASSES	70.	202.	.000	.000	.000	.000	.000	.000
** TOTAL **	850.	2454.	59,388	50,120	45,190	7,858	8,320	7,588

MIN. INERT WT. EXPENDABLE P/L 780.   REFURB. INERT WT. 473.
MIN. TOTAL WT. EXPENDABLE P/L 850.   REFURB. PROP. WT. 42.
REFURB. L/C S/S WT. 515.
REFURB. TOTAL WT. REUSEABLE P/L 515.   L/C SUBSYSTEMS WT. 2454.
MIN. PROPELLANT WT. REUSEABLE P/L 112.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1253.   FACTOR: (L/C-B/L+REF(L/C)) = 1089.45
MIN. TOTAL WT. REUSEABLE P/L 1365.   RATIO: INERT WT./TOTAL WT. = .91765

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.7482	.2993
TOTAL R&D	4.9701	1.9891
TOTAL UNIT	.7382	.2953

R&D PHASE: 3,0 YEARS   R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.230 MILLION/LAUNCH, INDEPENDENT $ 1.590 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323.00 N.M.   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-22. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 32

MISSION FLEMING NUMBER: 32 SUBFIELD: 0 NAME: COOP, APPLICATION SAT,B •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NCN-3B •• (BASELINE & LOW COST) ••

INCLINATION: 90,00 DEGREES ORBIT: 300,M(P) / 3000,M(A) 3
ΔV: 3800, FT/SEC AVERAGE POWER: 420, WATTS
LIFE: 2,0 YEARS SIZE: DIAMETER 6,5 FT, LENGTH 12,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1 DENSITY: 2,1 LBS/FT3

ACCEPTABLE MISSION MODES:
•• YES•• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• YES•• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES				1						1									
NEW UNITS (EXPENDABLE)				1						1									
NUMBER OF RETRIEVALS						1													
NEW UNITS + N-R INV (REUSEABLE)				1															
EXPERIMENT R&D APPLICATION				•						•									
OPERATION INDEPENDENT COST APPLICATION				•	•					•	•								

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)••		••R&D COST ($M)••			••UNIT COST ($M)••		
	•B/L•	•L/C•	•BASELINE•	•LOW COST•		•BASELINE•	•LOW COST•	
••SUBSYSTEM••				•NO RISK•	•RISK•		•NO RISK•	•RISK•
ADAPTER	30,	73,	,480	,412	,412	,118	,093	,093
EXPERIMENT MISSION EQUIPMENT	250,	459,	25,311 (2,40)	20,523	19,087	2,830 (1,90)	2,317	2,143
STRUCTURES AND MECHANISMS	120,	698,	4,937 (1,36)	3,346	2,944	,252	,529	,528
ELECTRICAL POWER	200,	385,	10,900 (1,75)	7,900	7,110	1,690	1,723	1,430
STABILITY & CONTROL	50,	109,	7,636	6,329	5,443	,750	,852	,784
ATTITUDE CONTROL	40,	315,	2,630	2,802	2,522	,260	,442	,442
PROPULSION	0,	0,	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	80,	143,	15,497	17,362	15,626	2,560	2,818	2,564
ENVIRONMENTAL CONTROL	20,	71,	1,400	1,280	1,152	,215	,224	,224
EXPENDABLE PROP, & GASSES	70,	202,	,000	,000	,000	,000	,000	,000
•• TOTAL ••	850,	2454,	68,791	59,954	54,295	8,645	8,997	8,208

MIN, INERT WT, EXPENDABLE P/L 780,
MIN, TOTAL WT, EXPENDABLE P/L 850,

REFURB, TOTAL WT, REUSEABLE P/L 915,
MIN, PROPELLANT WT, REUSEABLE P/L 112,
MIN, INERT WT, REUSEABLE P/L 1253,
MIN, TOTAL WT, REUSEABLE P/L 1365,

REFURB, INERT WT, 473,
REFURB, PROP, WT, 42,
REFURB, L/C S/S WT, 515,
L/C SUBSYSTEMS WT, 2454,
FIXED SUBSYSTEMS WT, 0,
FACTOR: [L/C-B/L-REF(L/C)] = 1089,45
RATIO: INERT WT,/TOTAL WT, = ,91765

•RISK SAVINGS ($M)•	•REUSE,•	•EXPEND,•
R&D EXPERIMENT	1,4366	,5746
TOTAL R&D	5,6585	2,2634
TOTAL UNIT	,7885	,3154

R&D PHASE: 3,5 YEARS R&D SPREAD 50% TIME AT ,40 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,350 MILLION/LAUNCH, INDEPENDENT $ 1,720 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 2,00 YEARS INVESTMENT SPREAD: 50% TIME AT ,50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 300,00 N,M, APOGEE ALTITUDE: 3000,00 N,M,
INITIAL ORBIT INCLINATION: 90,00 DEGREES TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-23. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 33

MISSION PLANNING NUMBER: 33 SUBFIELD: 0 NAME: MEDICAL NETWORK SAT. •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NCN-11 •• (BASELINE & LOW COST) ••

INCLINATION: ,00 DEGREES
DV: 14100, FT/SEC
LIFE: 5,0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2

ORBIT: SYNC,H(P) / SYNC,H(A)
AVERAGE POWER: 1000, WATTS
SIZE: DIAMETER 12,0 FT, LENGTH 15,0 FT,
DENSITY: 1,2 LBS/FT3

ACCEPTABLE MISSION MODES:
•• NO •• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• NO •• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	2																		
NEW UNITS (EXPENDABLE)	3																		
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•														

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)•• •B/L•	•L/C•	••R&D COST ($M)•• •BASELINE•		•LOW COST• •NO RISK•	•RISK•	••UNIT COST ($M)•• •BASELINE•		•LOW COST• •NO RISK•	•RISK•
••SUBSYSTEM••										
ADAPTER	70,	140,	,749		,569	,569	,153		,113	,113
EXPERIMENT MISSION EQUIPMENT	550,	1058,	33,549	(1,25)	22,515	21,218	3,273	(1,35)	2,818	2,637
STRUCTURES AND MECHANISMS	400,	1286,	12,593	(2,00)	8,121	7,146	,572		,799	,799
ELECTRICAL POWER	490,	839,	19,133	(1,75)	12,278	11,051	2,450		2,374	1,970
STABILITY & CONTROL	150,	259,	35,329		23,358	20,088	2,550		2,240	2,061
ATTITUDE CONTROL	70,	573,	3,500		3,817	3,435	,510		,703	,703
PROPULSION	0,	0,	,000		,000	,000	,000		,000	,000
TRACKING & TELEMETRY	150,	259,	38,571		42,393	38,154	3,600		3,904	3,552
ENVIRONMENTAL CONTROL	50,	98,	2,759		2,165	1,949	,510		,394	,394
EXPENDABLE PROP. & GASSES	140,	327,	,000		,000	,000	,000		,000	,000
•• TOTAL ••	2070,	4837,	145,169		115,516	103,609	13,615		13,344	12,199

MIN, INERT WT, EXPENDABLE P/L 1930,
MIN, TOTAL WT, EXPENDABLE P/L 2070,

REFURB, TOTAL WT, REUSEABLE P/L 803,
MIN, PROPELLANT WT, REUSEABLE P/L 194,
MIN, INERT WT, REUSEABLE P/L 2678,
MIN, TOTAL WT, REUSEABLE P/L 2873,

REFURB, INERT WT, 748,
REFURB, PROP, WT, 54,
REFURB, L/C S/S WT, 803,
L/C SUBSYSTEMS WT, 4837,
FIXED SUBSYSTEMS WT, 0,
FACTOR: (L/C-B/L+REF(L/C)) = 1963,84
RATIO: INERT WT,/TOTAL WT, = ,93237

•RISK SAVINGS ($M)• •REUSE,••EXPEND,•
R&D EXPERIMENT 1,5973 ,6398
TOTAL R&D 11,9373 4,7628
TOTAL UNIT 1,1454 ,4582

R&D PHASE: 4,5 YEARS R&D SPREAD 50% TIME AT ,20 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,950 MILLION/LAUNCH, INDEPENDENT $ 3,517 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS INVESTMENT SPREAD: 50% TIME AT ,50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323,00 N,M, APOGEE ALTITUDE: 19323,00 N,M,
INITIAL ORBIT INCLINATION: 28,50 DEGREES TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-24. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 34

```
MISSION FLEMING NUMBER: 34      SUBFIELD: 0        NAME: EDUCATIONAL BROADCAST           ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-12                                                              ** (BASELINE & LOW COST)  **

INCLINATION:   ,00 DEGREES                         ORBIT: SYNC,H(P)   / SYNC,H(A)
AV:   14100, FT/SEC                                AVERAGE POWER:   2000, WATTS
LIFE: 5,0 YEARS                                    SIZE:  DIAMETER 10,0 FT,  LENGTH 25,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  2             DENSITY:   1,8 LBS/FT3

ACCEPTABLE MISSION MODES:
   ** NO **    RETRIEVABLE PAYLOAD ( MODE 1 )                      ** YES**    EXPENDABLE PAYLOAD ( MODE 3 )
   ** NO **    RETRIEVABLE PAYLOAD ( MODE 2 )                      ** YES**    EXPENDABLE PAYLOAD ( MODE 4 )
```

**LAUNCH SCHEDULE: **	**YEAR**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			2																	
NEW UNITS (EXPENDABLE)			3																	
OPERATION INDEPENDENT COST APPLICATION			*	*	*	*	*													

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**		**R&D COST ($M)**			**UNIT COST ($M)**		
	B/L	*L/C*	*BASELINE*	*LOW COST* *NO RISK*	*RISK*	*BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	120,	213,	,970	,698	,698	,180	,129	,129
EXPERIMENT MISSION EQUIPMENT	1000,	1993,	41,366 (1,25)	28,643	26,638	4,800 (1,35)	4,235	3,918
STRUCTURES AND MECHANISMS	500,	1395,	13,300 (2,00)	8,481	7,639	,663	,845	,845
ELECTRICAL POWER	990,	1545,	26,854 (,75)	17,357	15,621	3,267	3,052	2,533
STABILITY & CONTROL	320,	473,	74,012	41,912	36,045	5,850	4,362	4,213
ATTITUDE CONTROL	100,	759,	4,200	4,416	3,975	,775	,875	,875
PROPULSION	0,	0,	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	200,	312,	47,403	48,590	43,731	4,200	4,324	3,935
ENVIRONMENTAL CONTROL	90,	116,	4,550	2,888	2,599	,890	,533	,533
EXPENDABLE PROP, & GASSES	200,	410,	,000	,000	,000	,000	,000	,000
** TOTAL **	3520,	7216,	212,855	153,185	136,945	20,625	18,354	16,780

```
MIN, INERT WT,      EXPENDABLE P/L  3320,     REFURB, INERT WT,          930,
MIN, TOTAL WT,      EXPENDABLE P/L  3520,     REFURB, PROP, WT,           54,     *RISK SAVINGS ($M)* *RE,SE,**EXPEND,*
                                              REFURB, L/C S/S WT,        954,          R&D EXPERIMENT    2,0053     ,8020
  REFURB, TOTAL WT, REUSEABLE P/L    954,     L/C SUBSYSTEMS WT,        7216,          TOTAL  R&D       16,2395    6,4958
MIN, PROPELLANT WT, REUSEABLE P/L    254,     FIXED SUBSYSTEMS WT,         0,          TOTAL  UNIT       1,5747     ,6299
MIN, INERT WT,      REUSEABLE P/L   4220,     FACTOR: (L/C-B/L-REF(L/C)) = 2741,79
MIN, TOTAL WT,      REUSEABLE P/L   4474,     RATIO: INERT WT,/TOTAL WT, =  ,94318

R&D PHASE: 6,0 YEARS      R&D SPREAD  50% TIME AT ,20 COST
NEW EXPERIMENT R&D: NO      ( EVERY  0 LAUNCHES )

OPERATING COST:  DEPENDENT $  2,850 MILLION/LAUNCH,   INDEPENDENT $  5,340 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $    ,000 MILLION
INVESTMENT PHASE: 3,00 YEARS    INVESTMENT SPREAD: 50% TIME AT ,50 COST              P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323,00 N,M,                 APOGEE ALTITUDE: 19323,00 N,M,
INITIAL ORBIT INCLINATION:  28,50 DEGREES       TUG MISSION DURATION:     ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,%   AND IN MODE 2 = 100,%
```

Table 5-25. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 35

```
MISSION FLEMING NUMBER: 35     SUBFIELD: 0      NAME: FOLLOW-    /S, DEMO, SAT         ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-13                                                             ** (BASELINE & LOW COST)  **

INCLINATION:   .00 DEGREES                       ORBIT: SYNC.        / SYNC.MIA)
AVI   14100. FT/SEC                              AVERAGE POW:     1000. WATTS
LIFE: 5.0 YEARS                                  SIZE: DIAM:   12.0 FT,  LENGTH 15.0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  7           DENSITY:   1.7 LBS/FT3

ACCEPTABLE MISSION MODES:
     ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
     ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )
```

**LAUNCH SCHEDULE: **	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES			2	2	2	2	2	2	2	2	2	2							
NEW UNITS (EXPENDABLE)			2	2	2	2	2	2	2	2	2	2							
NUMBER OF RETRIEVALS							2	2	2	2	2								
NEW UNITS + N-R INV (REUSEABLE)			3	2	2	2	2												
EXPERIMENT R&D APPLICATION			*		*		*		*		*								
OPERATION INDEPENDENT COST APPLICATION			*	*	*	*	*	*	*	*	*	*	*	*	*	*			

** WEIGHTS & COSTS: ** **SUBSYSTEM**	WEIGHT (LBS) B/L	WEIGHT (LBS) L/C	R&D COST ($M) BASELINE		R&D COST LOW COST NO RISK	R&D COST LOW COST RISK	UNIT COST ($M) BASELINE		UNIT COST LOW COST NO RISK	UNIT COST LOW COST RISK
ADAPTER	70.	140.	.749		.569	.569	.153		.113	.113
EXPERIMENT MISSION EQUIPMENT	515.	586.	42.931	(2.40)	35.433	32.953	3.253	(1.90)	2.713	2.509
STRUCTURES AND MECHANISMS	400.	1286.	16.554	(2.67)	10.841	9.540	.572		.799	.799
ELECTRICAL POWER	510.	869.	18.523	(1.75)	12.523	11.270	2.499		2.439	1.979
STABILITY & CONTROL	175.	293.	40.919		26.309	22.626	3.003		2.565	2.360
ATTITUDE CONTROL	80.	643.	3.753		4.052	3.647	.595		.769	.769
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	170.	282.	42.573		45.127	40.614	3.859		4.091	3.723
ENVIRONMENTAL CONTROL	50.	96.	2.753		2.165	1.949	.510		.394	.394
EXPENDABLE PROP. & GASSES	300.	711.	.000		.000	.000	.000		.000	.000
** TOTAL **	2070.	4905.	168.737		137.018	123.167	14.436		13.852	12.665

```
MIN. INERT WT.      EXPENDABLE P/L  1770.    REFURB. INERT WT.          748.
MIN. TOTAL WT.      EXPENDABLE P/L  2070.    REFURB. PROP. WT.          127.    *RISK SAVINGS ($M)* *REUSE.**EXPEND.*
                                             REFURB. L/C S/S WT.        875.        R&D EXPERIMENT   2.4503    .9921
  REFURB. TOTAL WT. REUSEABLE P/L    875.    L/C SUBSYSTEMS WT.        4905.        TOTAL  R&D      13.8511   5.5404
MIN. PROPELLANT WT. REUSEABLE P/L    427.    FIXED SUBSYSTEMS WT.         0.        TOTAL  UNIT      1.1862    .4745
MIN. INERT WT.      REUSEABLE P/L   2518.    FACTOR: (L/C-B/L-REF(L/C)) = 1959.78
MIN. TOTAL WT.      REUSEABLE P/L   2945.    RATIO: INERT WT./TOTAL WT. =  .85507

R&D PHASE: 4.5 YEARS     R&D SPREAD  50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES     ( EVERY  4 LAUNCHES )

OPERATING COST:  DEPENDENT $  2.050 MILLION/LAUNCH,  INDEPENDENT $  5.609 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $   .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST               P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323.00 N.M.                  APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION:  28.50 DEGREES        TUG MISSION DURATION:    .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
```

Table 5-26. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION No. 36

MISSION FLEMING NUMBER: 36   SUBFIELD: 0   NAME: TRACKING/DATA RELAY SAT.   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-5   ** (BASELINE & LOW COST) **

INCLINATION: ,00 DEGREES   ORBIT: SYNC,H(P) / SYNC,H(A)
ΔV: 14100, FT/SEC   AVERAGE POWER: 680, WATTS
LIFE: 3,0 YEARS   SIZE: DIAMETER 10,0 FT, LENGTH 17,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 3   DENSITY: 1,8 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	2	1		2	1			2	1									
NEW UNITS (EXPENDABLE)	2	2	1		2	1			2	1									
NUMBER OF RETRIEVALS					2	1			2										
NEW UNITS - N-R INV (REUSEABLE)	2	2	1																
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•							

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**		**R&D COST ($M)**			**UNIT COST ($M)**		
	B/L	*L/C*	*BASELINE*	*LOW COST*		*BASELINE*	*LOW COST*	
SUBSYSTEM				*NO RISK*	*RISK*		*NO RISK*	*RISK*
ADAPTER	80,	156,	,785	,599	,599	,159	,117	,117
EXPERIMENT MISSION EQUIPMENT	600,	1160,	26,845 (1,25)	18,267	16,989	3,460 (1,35)	2,990	2,766
STRUCTURES AND MECHANISMS	480,	1375,	15,960 (2,40)	10,295	9,059	,648	,837	,837
ELECTRICAL POWER	650,	1072,	21,450 (1,75)	14,110	12,699	2,730	2,626	2,160
STABILITY & CONTROL	110,	203,	20,351	14,243	12,249	1,790	1,705	1,569
ATTITUDE CONTROL	80,	643,	3,750	4,052	3,647	,595	,769	,769
PROPULSION	0,	0,	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	0,	0,	,000	,000	,000	,000	,000	,000
ENVIRONMENTAL CONTROL	60,	101,	3,200	2,375	2,137	,610	,434	,434
EXPENDABLE PROP, & GASSES	320,	732,	,000	,000	,000	,000	,000	,000
** TOTAL **	2380,	5441,	92,342	63,940	57,378	9,992	9,478	8,671

MIN, INERT WT, EXPENDABLE P/L 2060,   REFURB, INERT WT, 814,
MIN, TOTAL WT, EXPENDABLE P/L 2380,   REFURB, PROP, WT, 126,
REFURB, L/C S/S WT, 940,
REFURB, TOTAL WT, REUSEABLE P/L 940,   L/C SUBSYSTEMS WT, 9441,
MIN, PROPELLANT WT, REUSEABLE P/L 446,   FIXED SUBSYSTEMS WT, 0,
MIN, INERT WT, REUSEABLE P/L 2874,   FACTOR: (L/C-B/L-REF(L/C)) = 2121,26
MIN, TOTAL WT, REUSEABLE P/L 3320,   RATIO: INERT WT,/TOTAL WT, = ,86555

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	1,2787	,5115
TOTAL R&D	6,5617	2,6247
TOTAL UNIT	,8071	,3228

R&D PHASE: 4,0 YEARS   R&D SPREAD 50% TIME AT ,40 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,520 MILLION/LAUNCH, INDEPENDENT $ 2,900 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,50 COST   P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 19323,00 N,M,   APOGEE ALTITUDE: 19323,00 N,M,
INITIAL ORBIT INCLINATION: 28,50 DEGREES   TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,%   AND IN MODE 2 = 100,%

Table 5-27. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION 37

MISSION FLEMING NUMBER: 37 SUBFIELD: 0 NAME: PLANETARY RELAY SAT. •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NCN-14 •• (BASELINE & LOW COST) ••

INCLINATION: .00 DEGREES
ΔV: 14100. FT/SEC
LIFE: 5.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 3

ORBIT: SYNC.H(P) / SYNC.H(A)
AVERAGE POWER: 680. WATTS
SIZE: DIAMETER 10.0 FT. LENGTH 20.0 FT.
DENSITY: .6 LBS/FT3

ACCEPTABLE MISSION MODES:
•• YES•• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• YES•• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	2	1				1	2				1	2							
NEW UNITS (EXPENDABLE)	3	1				1	2				1	2							
NUMBER OF RETRIEVALS						1	2				1	1							
NEW UNITS + NOR INV (REUSEABLE)	2	1				1													
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)•• •B/L•	•L/C•	••R&D COST ($M)•• •BASELINE•	•LOW COST• •NO RISK•	•RISK•	••UNIT COST ($M)•• •BASELINE•	•LOW COST• •NO RISK•	•RISK•
••SUBSYSTEM••								
ADAPTER	35.	82.	.520	.437	.437	.124	.096	.096
EXPERIMENT MISSION EQUIPMENT	250.	459.	25.043 (1.25)	16.931	15.718	1.950 (1.35)	1.646	1.523
STRUCTURES AND MECHANISMS	200.	947.	11.520 (2.40)	7.585	6.675	.356	.649	.649
ELECTRICAL POWER	275.	508.	12.994 (1.75)	9.240	8.316	1.925	1.931	1.602
STABILITY & CONTROL	45.	100.	10.956	9.226	7.934	.665	.777	.715
ATTITUDE CONTROL	35.	265.	2.460	2.563	2.304	.220	.387	.387
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	0.	0.	.000	.000	.000	.000	.000	.000
ENVIRONMENTAL CONTROL	25.	76.	1.600	1.472	1.325	.258	.261	.261
EXPENDABLE PROP. & GASSES	135.	380.	.000	.000	.000	.000	.000	.000
•• TOTAL ••	1000.	2818.	65.093	47.424	42.712	5.510	5.747	5.233

MIN. INERT WT. EXPENDABLE P/L 865.
MIN. TOTAL WT. EXPENDABLE P/L 1000.

REFURB. TOTAL WT. REUSEABLE P/L 618.
MIN. PROPELLANT WT. REUSEABLE P/L 218.
MIN. INERT WT. REUSEABLE P/L 1400.
MIN. TOTAL WT. REUSEABLE P/L 1618.

REFURB. INERT WT. 535.
REFURB. PROP. WT. 83.
REFURB. L/C S/S WT. 618.
L/C SUBSYSTEMS WT. 2818.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C+B/L+REF(L/C)) = 1199.72
RATIO: INERT WT./TOTAL WT. = .86500

•RISK SAVINGS ($M)•	•REUSE.•	•EXPEND.•
R&D EXPERIMENT	1.1831	.4732
TOTAL R&D	4.7124	1.8850
TOTAL UNIT	.5139	.2055

R&D PHASE: 3.5 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ .920 MILLION/LAUNCH, INDEPENDENT $ 1.525 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-28. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 50

MISSION FLEMING NUMBER: 50 SUBFIELD: 0 NAME: MARS VIKING ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-1 ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES ORBIT: ESCAPE / MARS
ΔV: 15400. FT/SEC AVERAGE POWER: 800. WATTS
LIFE: 1.0 YEARS SIZE: DIAMETER 10.0 FT, LENGTH 12.0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1 DENSITY: 8.2 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1) ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2) ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1		1																
NEW UNITS (EXPENDABLE)	2		1																
EXPERIMENT R&D APPLICATION	*		*																
OPERATION INDEPENDENT COST APPLICATION	*		*																

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*		**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM											
ADAPTER	150.	254.		1,090		,760	,760	,192		,136	,136
EXPERIMENT MISSION EQUIPMENT	2558.	2558.	(*B/L)	40,100	(*B/L)	40,100	37,293	20,500	(*B/L)	20,500	18,962
STRUCTURES AND MECHANISMS	918.	1412.		9,249	(1,36)	5,963	5,247	,673		,652	,652
ELECTRICAL POWER	428.	746.		9,639	(1,00)	6,564	5,908	2,311		2,262	1,877
STABILITY & CONTROL	85.	165.		9,100		6,740	5,796	1,333		1,359	1,251
ATTITUDE CONTROL	22.	126.		1,930		1,746	1,571	,130		,218	,218
PROPULSION	495.	703.		40,500		47,316	42,585	5,300		6,162	6,162
TRACKING & TELEMETRY	122.	221.		14,884		16,874	15,186	3,233		3,577	3,255
ENVIRONMENTAL CONTROL	37.	87.		2,165		1,845	1,661	,382		,332	,332
EXPENDABLE PROP. & GASSES	3305.	4695.		,000		,000	,000	,000		,000	,000
** TOTAL **	7720.	10967.		128,647		127,907	116,007	34,051		35,398	33,045

MIN. INERT WT. EXPENDABLE P/L 4415. REFURB. INERT WT. 1095.
MIN. TOTAL WT. EXPENDABLE P/L 7720. REFURB. PROP. WT. 820.
REFURB. L/C S/S WT. 1468.
REFURB. TOTAL WT. REUSEABLE P/L 1914. L/C SUBSYSTEMS WT. 8409.
MIN. PROPELLANT WT. REUSEABLE P/L 4125. FIXED SUBSYSTEMS WT. 2558.
MIN. INERT WT. REUSEABLE P/L 5510. FACTOR: (L/C-B/L-REF(L/C)) = 1778.97
MIN. TOTAL WT. REUSEABLE P/L 9634. RATIO: INERT WT./TOTAL WT. = .57189

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	2,8073	1,1228
TOTAL R&D	11,9006	4,7602
TOTAL UNIT	2,3526	,9411

R&D PHASE: 5.0 YEARS R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 4,380 MILLION/LAUNCH, INDEPENDENT $ 7,200 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS INVESTMENT SPREAD: 50% TIME AT ,50 COST P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: ,00 N.M. APOGEE ALTITUDE: ,00 N.M.
INITIAL ORBIT INCLINATION: 30,00 DEGREES TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-29. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 51

```
MISSION FLEMING NUMBER: 51      SUBFIELD: 0      NAME: MARS SURFACE SAMPLE RTRN          ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-20                                                              ** (BASELINE & LOW COST)  **

INCLINATION: 30,00 DEGREES                       ORBIT: ESCAPE       / MARS
DV:   15400, FT/SEC                              AVERAGE POWER:  15300, WATTS
LIFE: 3,0 YEARS                                  SIZE: DIAMETER 14,0 FT,  LENGTH 23,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  2           DENSITY:   3,2 LBS/FT3

ACCEPTABLE MISSION MODES:
   ** NO **   RETRIEVABLE PAYLOAD ( MODE 1 )                 ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
   ** NO **   RETRIEVABLE PAYLOAD ( MODE 2 )                 ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )
```

**LAUNCH SCHEDULE: **	**YEAR**	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES													2							
NEW UNITS (EXPENDABLE)													2							
OPERATION INDEPENDENT COST APPLICATION													*	*	*					

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*		**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM											
ADAPTER	345,	484,		1,650		1,044	1,044	,248		,165	,165
EXPERIMENT MISSION EQUIPMENT	7290,	7290,	(*B/L)	56,810	(*B/L)	56,810	52,833	24,500	(*B/L)	24,500	22,662
STRUCTURES AND MECHANISMS	480,	1375,		13,260	(2,00)	8,579	7,549	,646		,837	,837
ELECTRICAL POWER	960,	1504,		26,460	(1,75)	17,096	15,386	3,226		3,019	2,506
STABILITY & CONTROL	0,	0,		,000		,000	,000	,000		,000	,000
ATTITUDE CONTROL	90,	705,		3,950		4,250	3,825	,680		,826	,826
PROPULSION	345,	430,		32,500		34,968	31,471	3,900		3,991	3,991
TRACKING & TELEMETRY	260,	361,		44,582		41,824	37,644	4,888		4,680	4,259
ENVIRONMENTAL CONTROL	40,	89,		2,300		1,925	1,732	,420		,348	,348
EXPENDABLE PROP, & GASSES	1590,	1983,		,000		,000	,000	,000		,000	,000
** TOTAL **	11400,	14221,		181,512		166,497	151,485	38,558		38,365	35,593

```
MIN, INERT WT,      EXPENDABLE P/L  9810,    REFURB, INERT WT,      1187,
MIN, TOTAL WT,      EXPENDABLE P/L 11400,    REFURB, PROP, WT,       192,     *RISK SAVINGS ($M)* *REUSE,**EXPEND,*
                                             REFURB, L/C S/S WT,     672,         R&D EXPERIMENT   3,9767   1,5907
  REFURB, TOTAL WT, REUSEABLE P/L  1379,     L/C SUBSYSTEMS WT,     6931,         TOTAL  R&D      15,0127   6,0051
MIN, PROPELLANT WT, REUSEABLE P/L  1782,     FIXED SUBSYSTEMS WT,   7290,         TOTAL  UNIT      2,7720   1,1088
MIN, INERT WT,      REUSEABLE P/L 10997,     FACTOR: (L/C*B/L-REF(L/C)) = 2148,93
MIN, TOTAL WT,      REUSEABLE P/L 12779,     RATIO: INERT WT,/TOTAL WT, =  ,86053

R&D PHASE: 5,0 YEARS     R&D SPREAD  50% TIME AT ,20 COST
NEW EXPERIMENT R&D: NO      ( EVERY  0 LAUNCHES )

OPERATING COST: DEPENDENT $  4,650 MILLION/LAUNCH,  INDEPENDENT $ 10,373 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $   ,000 MILLION
INVESTMENT PHASE: 3,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,90 COST                P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE:      ,00 N,M,                  APOGEE ALTITUDE:      ,00 N,M,
INITIAL ORBIT INCLINATION:  30,00 DEGREES        TUG MISSION DURATION:     ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,%   AND IN MODE 2 = 100,%
```

Table 5-30. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 52

MISSION FLEWING NUMBER: 52   SUBFIELD: 0   NAME: VENUS EXPLORER/ORBITER   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-5   ** (BASELINE & LOW COST) **

INCLINATION: 30,00 DEGREES   ORBIT: ESCAPE / VENUS
*V: 13400, FT/SEC   AVERAGE POWER: 500, WATTS
LIFE: 2,0 YEARS   SIZE: DIAMETER 5,0 FT, LENGTH 12,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 4,2 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		1																	
NEW UNITS (EXPENDABLE)		2																	
NUMBER OF RETRIEVALS																			
OPERATION INDEPENDENT COST APPLICATION		*	*																

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	30,	30, (*B/L)	,480 (*B/L)	,480	,480	,118 (*B/L)	,118	,118
EXPERIMENT MISSION EQUIPMENT	50,	50, (*B/L)	14,423 (*B/L)	14,423	13,413	1,700 (*B/L)	1,700	1,572
STRUCTURES AND MECHANISMS	100,	100, (*B/L)	4,352 (*B/L)	4,352	3,830	,225 (*B/L)	,225	,225
ELECTRICAL POWER	140,	140, (*B/L)	8,932 (*B/L)	8,932	8,039	1,456 (*B/L)	1,456	1,208
STABILITY & CONTROL	30,	30, (*B/L)	4,666 (*B/L)	4,666	4,013	,420 (*B/L)	,420	,386
ATTITUDE CONTROL	40,	40, (*B/L)	2,620 (*B/L)	2,620	2,358	,260 (*B/L)	,260	,260
PROPULSION	70,	70, (*B/L)	12,300 (*B/L)	12,300	11,070	,940 (*B/L)	,940	,940
TRACKING & TELEMETRY	70,	70, (*B/L)	14,055 (*B/L)	14,055	12,649	2,390 (*B/L)	2,380	2,166
ENVIRONMENTAL CONTROL	20,	20, (*B/L)	1,400 (*B/L)	1,400	1,260	,215 (*B/L)	,215	,215
EXPENDABLE PROP, & GASSES	450,	450, (*B/L)	,000 (*B/L)	,000	,000	,000 (*B/L)	,000	,000
** TOTAL **	1000,	1000,	63,229	63,228	57,112	7,714	7,714	7,091

MIN, INERT WT,   EXPENDABLE P/L 550,   REFURB, INERT WT, 485,
MIN, TOTAL WT,   EXPENDABLE P/L 1000,   REFURB, PROP, WT, 396,
REFURB, L/C S/S WT, 0,
REFURB, TOTAL WT, REUSEABLE P/L 881,   L/C SUBSYSTEMS WT, 0,
MIN, PROPELLANT WT, REUSEABLE P/L 846,   FIXED SUBSYSTEMS WT, 1000,
MIN, INERT WT,   REUSEABLE P/L 1035,   FACTOR: (L/C-B/L-REF(L/C)) = *1,00
MIN, TOTAL WT,   REUSEABLE P/L 1881,   RATIO: INERT WT,/TOTAL WT, = ,55000

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	1,0096	,4038
TOTAL R&D	6,1151	2,4463
TOTAL UNIT	,6228	,2491

R&D PHASE: 3,0 YEARS   R&D SPREAD 50% TIME AT ,40 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,230 MILLION/LAUNCH, INDEPENDENT $ 1,500 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 2,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,50 COST   P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: ,00 N,M,   APOGEE ALTITUDE: ,00 N,M,
INITIAL ORBIT INCLINATION: 30,00 DEGREES   TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-31. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 53

MISSION FLEMING NUMBER: 53 SUBFIELD: 0 NAME: VENUS RADAR MAPPING ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-6 ** (BASELINE & LOW COST) **

INCLINATION: 30,00 DEGREES
ORBIT: ESCAPE / VENUS
*V: 13400, FT/SEC
AVERAGE POWER: 1000, WATTS
LIFE: 2,0 YEARS
SIZE: DIAMETER 10,0 FT, LENGTH 12,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1
DENSITY: 8,4 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

**LAUNCH SCHEDULE: **	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES				1															
NEW UNITS (EXPENDABLE)				2															
NUMBER OF RETRIEVALS																			
OPERATION INDEPENDENT COST APPLICATION				*	*														

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LC* COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LC* COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	264,	264, (=B/L)	1,450 (=B/L)	1,450	1,450	,227 (=B/L)	,227	,227
EXPERIMENT MISSION EQUIPMENT	322,	322, (=B/L)	27,432 (=B/L)	27,432	25,512	5,600 (=B/L)	5,600	5,180
STRUCTURES AND MECHANISMS	318,	318, (=B/L)	7,688 (=B/L)	7,688	6,941	,490 (=B/L)	,490	,490
ELECTRICAL POWER	287,	287, (=B/L)	13,461 (=B/L)	13,461	12,115	1,980 (=B/L)	1,980	1,643
STABILITY & CONTROL	99,	99, (=B/L)	14,988 (=B/L)	14,988	12,890	1,600 (=B/L)	1,600	1,472
ATTITUDE CONTROL	0,	0, (=B/L)	,000 (=B/L)	,000	,000	,000 (=B/L)	,000	,000
PROPULSION	670,	670, (=B/L)	48,500 (=B/L)	48,500	43,650	6,950 (=B/L)	6,950	6,950
TRACKING & TELEMETRY	180,	180, (=B/L)	27,743 (=B/L)	27,743	24,969	3,960 (=B/L)	3,960	3,604
ENVIRONMENTAL CONTROL	60,	60, (=B/L)	3,200 (=B/L)	3,200	2,880	,610 (=B/L)	,610	,610
EXPENDABLE PROP, & GASSES	5700,	5700, (=B/L)	,000 (=B/L)	,000	,000	,000 (=B/L)	,000	,000
** TOTAL **	7900,	7900,	144,662	144,662	130,406	21,417	21,417	20,176

MIN, INERT WT, EXPENDABLE P/L 2200,
MIN, TOTAL WT, EXPENDABLE P/L 7900,

REFURB, INERT WT, 1001,
REFURB, PROP, WT, 2593,
REFURB, L/C S/S WT, 0,
L/C SUBSYSTEMS WT, 0,
FIXED SUBSYSTEMS WT, 7900,
FACTOR: (L/C-B/L-REF(L/C)) = -1,00
RATIO: INERT WT,/TOTAL WT, = ,27848

REFURB, TOTAL WT, REUSEABLE P/L 3594,
MIN, PROPELLANT WT, REUSEABLE P/L 8293,
MIN, INERT WT, REUSEABLE P/L 3201,
MIN, TOTAL WT, REUSEABLE P/L 11494,

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	1,9202	,7681
TOTAL R&D	14,2555	5,7022
TOTAL UNIT	1,2413	,4964

R&D PHASE: 4,5 YEARS R&D SPREAD 50% TIME AT ,20 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 2,900 MILLION/LAUNCH, INDEPENDENT $ 4,400 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS INVESTMENT SPREAD: 50% TIME AT ,50 COST
P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: ,00 N,M, APOGEE ALTITUDE: ,00 N,M,
INITIAL ORBIT INCLINATION: 30,00 DEGREES TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-32. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 54 (Subfield 1)

MISSION FLEMING NUMBER: 54   SUBFIELD: 1   NAME: VENUS EXPLORER/LANDER   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: AP..7   ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES   ORBIT: ESCAPE / VENUS
ΔV: 13400. FT/SEC   AVERAGE POWER: 700. WATTS
LIFE: 1.0 YEARS   SIZE: DIAMETER 10.0 FT. LENGTH 30.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 3.1 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES							1												
NEW UNITS (EXPENDABLE)							2												
NUMBER OF RETRIEVALS																			
OPERATION INDEPENDENT COST APPLICATION							•												

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	160.	160. (=B/L)	1.120 (=B/L)	1.120	1.120	.194 (=B/L)	.194	.194
EXPERIMENT MISSION EQUIPMENT	600.	600. (=B/L)	24.000 (=B/L)	24.000	22.320	8.400 (=B/L)	8.400	7.770
STRUCTURES AND MECHANISMS	450.	450. (=B/L)	8.908 (=B/L)	8.958	7.839	.621 (=B/L)	.621	.621
ELECTRICAL POWER	350.	350. (=B/L)	8.575 (=B/L)	8.575	7.717	2.135 (=B/L)	2.135	1.772
STABILITY & CONTROL	65.	65. (=B/L)	9.100 (=B/L)	9.100	7.826	1.333 (=B/L)	1.333	1.224
ATTITUDE CONTROL	20.	20. (=B/L)	1.830 (=B/L)	1.830	1.647	.115 (=B/L)	.115	.115
PROPULSION	600.	600. (=B/L)	45.500 (=B/L)	45.500	40.950	6.300 (=B/L)	6.300	6.300
TRACKING & TELEMETRY	100.	100. (=B/L)	12.900 (=B/L)	12.900	11.610	2.880 (=B/L)	2.880	2.621
ENVIRONMENTAL CONTROL	35.	35. (=B/L)	2.075 (=B/L)	2.075	1.867	.373 (=B/L)	.373	.370
EXPENDABLE PROP. & GASSES	5020.	5020. (=B/L)	.000 (=B/L)	.000	.000	.000 (=B/L)	.000	.000
** TOTAL **	7420.	7420.	114.008	114.008	102.897	22.345	22.345	20.986

MIN. INERT WT.   EXPENDABLE P/L 2400.   REFURB. INERT WT. 1050.
MIN. TOTAL WT.   EXPENDABLE P/L 7420.   REFURB. PROP. WT. 2197.
REFURB. L/C S/S WT. 0.
REFURB. TOTAL WT. REUSEABLE P/L 3247.   L/C SUBSYSTEMS WT. 0.
MIN. PROPELLANT WT. REUSEABLE P/L 7217.   FIXED SUBSYSTEMS WT. 7420.
MIN. INERT WT.   REUSEABLE P/L 3450.   FACTOR: [L/C-B/L-REF(L/C)] = -1.00
MIN. TOTAL WT.   REUSEABLE P/L 10667.   RATIO: INERT WT./TOTAL WT. = .32345

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.6503	.6720
TOTAL R&D	11.1112	4.4444
TOTAL UNIT	1.3586	.5434

R&D PHASE: 4.0 YEARS   R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 3.050 MILLION/LAUNCH, INDEPENDENT $ 4.600 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: .00 N.M.   APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 30.00 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-33. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 54 (Subfield 2)

```
MISSION FLEMING NUMBER: 54      SUBFIELD: 2       NAME: VENUS EXPLORER/LANDER          ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-8                                                              ** (BASELINE & LOW COST)  **

INCLINATION: 30.00 DEGREES                        ORBIT: ESCAPE       / VENUS
DV:   13400. FT/SEC                               AVERAGE POWER:    700. WATTS
LIFE: 1.0 YEARS                                   SIZE:  DIAMETER 10.0 FT,  LENGTH 30.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT:  1            DENSITY:    2.0 LBS/FT3

ACCEPTABLE MISSION MODES:
   ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                 ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
   ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                 ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )
```

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES										1									
NEW UNITS (EXPENDABLE)										2									
NUMBER OF RETRIEVALS																			
OPERATION INDEPENDENT COST APPLICATION										*									

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*		**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	100.	100.	(*B/L)	.880	(*B/L)	.880	.880	.170	(*B/L)	.170	.170
EXPERIMENT MISSION EQUIPMENT	1210.	1210.	(*B/L)	30,800	(*B/L)	30.800	28.644	12.900	(*B/L)	12.900	11.932
STRUCTURES AND MECHANISMS	350.	350.	(*B/L)	8,228	(*B/L)	8.228	7.241	.525	(*B/L)	.525	.525
ELECTRICAL POWER	300.	300.	(*B/L)	7,860	(*B/L)	7.860	7.074	1.995	(*B/L)	1.995	1.656
STABILITY & CONTROL	70.	70.	(*B/L)	7,550	(*B/L)	7.550	6.493	1.090	(*B/L)	1.090	1.003
ATTITUDE CONTROL	20.	20.	(*B/L)	1,830	(*B/L)	1.830	1.647	.115	(*B/L)	.115	.115
PROPULSION	350.	350.	(*B/L)	32,500	(*B/L)	32.500	29.250	3.950	(*B/L)	3.950	3.950
TRACKING & TELEMETRY	100.	100.	(*B/L)	12,900	(*B/L)	12.900	11.610	2.840	(*B/L)	2.840	2.621
ENVIRONMENTAL CONTROL	30.	30.	(*B/L)	1,850	(*B/L)	1.850	1.665	.320	(*B/L)	.320	.320
EXPENDABLE PROP. & GASSES	2220.	2220.	(*B/L)	.000	(*B/L)	.000	.000	.000	(*B/L)	.000	.000
** TOTAL **	4750.	4750.		104,398		104.398	94.504	23.945		23.945	22.292

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MIN. INERT WT.      EXPENDABLE P/L  2530.      REFURB. INERT WT.          890.
MIN. TOTAL WT.      EXPENDABLE P/L  4750.      REFURB. PROP. WT.          781.
                                               REFURB. L/C S/S WT.          0.
  REFURB. TOTAL WT. REUSEABLE P/L   1672.      L/C SUBSYSTEMS WT.           0.
MIN. PROPELLANT WT. REUSEABLE P/L   3001.      FIXED SUBSYSTEMS WT.  4750.
MIN. INERT WT.      REUSEABLE P/L   3420.      FACTOR: (L/C-B/L-REF(L/C)) =   =1.00
MIN. TOTAL WT.      REUSEABLE P/L   6422.      RATIO: INERT WT./TOTAL WT. =  .53263

*RISK SAVINGS ($M)* *REUSE,**EXPEND.*
     R&D EXPERIMENT    2.1563    .0624
     TOTAL  R&D        9.8914   3.9577
     TOTAL  UNIT       1.6531    .6612

R&D PHASE: 4.0 YEARS      R&D SPREAD  50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO      ( EVERY   0 LAUNCHES )

OPERATING COST:  DEPENDENT $  3.250 MILLION/LAUNCH,  INDEPENDENT $  5.000 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $    .000 MILLION
INVESTMENT PHASE: 3.00 YEARS    INVESTMENT SPREAD: 50% TIME AT .50 COST        P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE:        .00 N.M.                  APOGEE ALTITUDE:         .00 N.M.
INITIAL ORBIT INCLINATION:  30.00 DEGREES          TUG MISSION DURATION:     .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
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Table 5-34. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION 55

MISSION FUNDING NUMBER: 55 SUBFIELD: 0 NAME: JUPITER PIONEER ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NP-611 ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES
DV: 22700. FT/SEC
LIFE: 2.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2

ORBIT: ESCAPE / JUPITER
AVERAGE POWER: 440. WATTS
SIZE: DIAMETER 10.0 FT, LENGTH 15.0 FT,
DENSITY: .8 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)
** YES** RETRIEVABLE PAYLOAD (MODE 2)
** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES				2															
NEW UNITS (EXPENDABLE)				2															
NUMBER OF RETRIEVALS																			
OPERATION INDEPENDENT COST APPLICATION				*	*														

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *P/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	30.	30. (*R/L)	.487 (*R/L)	.480	.440	.119 (*R/L)	.119	.119
EXPERIMENT MISSION EQUIPMENT	50.	50. (*R/L)	14.423 (*R/L)	14.423	13.413	1.700 (*R/L)	1.700	1.572
STRUCTURES AND MECHANISMS	100.	100. (*R/L)	6.400 (*R/L)	6.400	5.532	.225 (*R/L)	.225	.225
ELECTRICAL POWER	130.	130. (*R/L)	8.531 (*R/L)	8.531	7.673	1.404 (*R/L)	1.404	1.155
STABILITY & CONTROL	30.	30. (*R/L)	4.656 (*R/L)	4.654	4.013	.420 (*R/L)	.420	.355
ATTITUDE CONTROL	40.	40. (*R/L)	2.620 (*R/L)	2.620	2.358	.290 (*R/L)	.290	.280
PROPULSION	65.	65. (*R/L)	11.700 (*R/L)	11.700	10.530	.880 (*R/L)	.550	.580
TRACKING & TELEMETRY	70.	70. (*R/L)	14.055 (*R/L)	14.055	12.649	2.343 (*R/L)	2.380	2.166
ENVIRONMENTAL CONTROL	20.	20. (*R/L)	1.400 (*R/L)	1.400	1.260	.215 (*R/L)	.215	.215
EXPENDABLE PROP. & GASSES	335.	315. (*R/L)	.000 (*R/L)	.000	.000	.000 (*R/L)	.000	.000
** TOTAL **	830.	500.	64.275	64.279	58.014	7.602	7.602	6.988

MIN. INERT WT. EXPENDABLE P/L 565.
MIN. TOTAL WT. EXPENDABLE P/L 930.

REFURB. TOTAL WT. RELEASABLE P/L 781.
MIN. PROPELLANT WT. RELEASABLE P/L 672.
MIN. INERT WT. RELEASABLE P/L 1040.
MIN. TOTAL WT. RELEASABLE P/L 1711.

REFURB. INERT WT. 475.
REFURB. PROP. WT. 307.
REFURB. L/C S/S WT. 0.
L/C SUBSYSTEMS WT. 0.
FIXED SUBSYSTEMS WT. 900.
FACTOR: (L/C-B/L-REF(L/C)) = -1.00
RATIO: INERT WT./TOTAL WT. = .60753

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.0095	.4038
TOTAL R&D	6.2919	2.5346
TOTAL UNIT	.6143	.2456

R&D PHASE: 3.0 YEARS R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.200 MILLION/LAUNCH, INDEPENDENT $ 1.898 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: .00 N.M. APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 30.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-35. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 57

MISSION PLANNING NUMBER: 57 SUBFIELD: 0 NAME: JUPITER TOPS ORBITER/PRB ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-13 ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES
ΔV: 22700. FT/SEC
LIFE: 3.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1

ORBIT: ESCAPE / JUPITER
AVERAGE POWER: 450. WATTS
SIZE: DIAMETER 10.0 FT, LENGTH 15.0 FT,
DENSITY: 2.8 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES							1		1										
NEW UNITS (EXPENDABLE)							2		1										
NUMBER OF RETRIEVALS																			
EXPERIMENT R&D APPLICATION							*		*										
OPERATION INDEPENDENT COST APPLICATION							*	*	*	*	*								

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	110.	110. (*B/L)	.925 (*B/L)	.925	.925	.176 (*B/L)	.176	.176
EXPERIMENT MISSION EQUIPMENT	330.	330. (*B/L)	33.947 (*B/L)	33.947	31.571	5.603 (*B/L)	5.603	5.153
STRUCTURES AND MECHANISMS	315.	315. (*B/L)	7.889 (*B/L)	7.888	6.941	.488 (*B/L)	.488	.483
ELECTRICAL POWER	380.	380. (*B/L)	15.794 (*B/L)	15.794	14.215	2.274 (*B/L)	2.274	1.829
STABILITY & CONTROL	85.	85. (*B/L)	15.761 (*B/L)	15.761	13.[illegible]	1.350 (*B/L)	1.350	1.242
ATTITUDE CONTROL	40.	40. (*B/L)	2.623 (*B/L)	2.623	2.358	.240 (*B/L)	.240	.260
PROPULSION	250.	250. (*B/L)	26.500 (*B/L)	26.500	23.850	2.900 (*B/L)	2.900	2.900
TRACKING & TELEMETRY	170.	170. (*B/L)	32.977 (*B/L)	32.977	29.679	3.859 (*B/L)	3.859	3.512
ENVIRONMENTAL CONTROL	40.	40. (*B/L)	2.300 (*B/L)	2.300	2.070	.423 (*B/L)	.423	.423
EXPENDABLE PROP. & GASSES	1570.	1570. (*B/L)	.000 (*B/L)	.000	.000	.000 (*B/L)	.000	.000
** TOTAL **	3290.	3290.	138.712	138.712	125.104	17.257	17.257	16.007

MIN. INERT WT. EXPENDABLE P/L 1720. REFURB. INERT WT. 794.
MIN. TOTAL WT. EXPENDABLE P/L 3290. REFURB. PROP. WT. 724.
REFURB. L/C S/S WT. 0.
REFURB. TOTAL WT. RELEASABLE P/L 1518. L/C SUBSYSTEMS WT. 0.
MIN. PROPELLANT WT. RELEASABLE P/L 2294. FIXED SUBSYSTEMS WT. 3290.
MIN. INERT WT. RELEASABLE P/L 2514. FACTOR: (L/C-B/L-REF(L/C)) = -1.00
MIN. TOTAL WT. RELEASABLE P/L 4808. RATIO: INERT WT./TOTAL WT. = .52280

RISK SAVINGS ($M) *RE.SE.* *EXPEND.*
R&D EXPERIMENT 2.3763 .9525
TOTAL R&D 13.5449 5.4194
TOTAL UNIT 1.2503 .5000

R&D PHASE: 4.5 YEARS R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.420 MILLION/LAUNCH, INDEPENDENT $ 3.500 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: .00 N.M. APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 30.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-36. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 58

MISSION FLEMING NUMBER: 58   SUBFIELD: 0   NAME: URANUS TOPS ORBITER/PROB   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-14   ** (BASELINE & LOW COST) **

INCLINATION: 30,00 DEGREES   ORBIT: ESCAPE / URANUS
*V: 25000, FT/SEC   AVERAGE POWER: 480, WATTS
LIFE: 7,0 YEARS   SIZE: DIAMETER 10,0 FT, LENGTH 15,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1   DENSITY: 3,1 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1)   ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2)   ** YES ** EXPENDABLE PAYLOAD (MODE 4)

**LAUNCH SCHEDULE: **	**YEAR** 79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES								1			1								
NEW UNITS (EXPENDABLE)								2			1								
EXPERIMENT R&D APPLICATION								•			•								
OPERATION INDEPENDENT COST APPLICATION								•	•	•	•	•	•	•	•	•	•		

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*		**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	120.	213.		,970		,698	,698	,130		,129	,129
EXPERIMENT MISSION EQUIPMENT	730.	730.	(*B/L)	68,241	(*B/L)	68,241	63,464	9,350	(*B/L)	9,350	8,649
STRUCTURES AND MECHANISMS	315.	1169.		7,889	(1,36)	5,108	4,495	,498		,749	,749
ELECTRICAL POWER	380.	380.	(*B/L)	15,794	(*B/L)	15,794	14,215	2,204	(*B/L)	2,204	1,929
STABILITY & CONTROL	85.	165.		24,070		17,831	15,335	1,350		1,359	1,251
ATTITUDE CONTROL	40.	315.		2,620		2,802	2,522	,260		,442	,442
PROPULSION	250.	445.		26,500		35,678	32,110	2,900		4,130	4,138
TRACKING & TELEMETRY	170.	282.		51,313		53,395	48,056	3,859		4,091	3,723
ENVIRONMENTAL CONTROL	40.	89.		2,300		1,925	1,732	,420		,348	,348
EXPENDABLE PROP, & GASSES	1570.	2792.		,000		,000	,000	,000		,000	,000
** TOTAL **	3[illegible].	6581.		199,696		201,472	182,626	21,011		22,780	21,227

MIN, INERT WT,   EXPENDABLE P/L 2130.   REFURB, INERT WT, 818.
MIN, TOTAL WT,   EXPENDABLE P/L 3700.   REFURB, PROP, WT, 603.
REFURB, L/C S/S WT, 1181.
REFURB, TOTAL WT, REUSEABLE P/L 1421.   L/C SUBSYSTEMS WT, 2471.
MIN, PROPELLANT WT, REUSEABLE P/L 2173.   FIXED SUBSYSTEMS WT, 1110.
MIN, INERT WT,   REUSEABLE P/L 2948.   FACTOR: [L/C-B/L-REF(L/C)] = 1699,47
MIN, TOTAL WT,   REUSEABLE P/L 5121.   RATIO: INERT WT,/TOTAL WT, = ,57568

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	4,7769	1,9107
TOTAL R&D	18,8455	7,5382
TOTAL UNIT	1,5529	,6211

R&D PHASE: 6,5 YEARS   R&D SPREAD 50% TIME AT ,20 COST
NEW EXPERIMENT R&D: YES   (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 2,900 MILLION/LAUNCH, INDEPENDENT $ 4,380 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 3,00 YEARS   INVESTMENT SPREAD: 50% TIME AT ,50 COST   P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: ,00 N,M,   APOGEE ALTITUDE: ,00 N,M,
INITIAL ORBIT INCLINATION: 30,00 DEGREES   TUG MISSION DURATION: ,00 HOURS

% RETRIEVER PAYLOAD WEIGHT: IN MODE 1 = 100,%   AND IN MODE 2 = 100,%

Table 5-37. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 59

MISSION FLEMING NUMBER: 59   SUBFIELD: 0   NAME: ASTEROID SURVEY   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-15   ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES
ΔV: 20000. FT/SEC
LIFE: 2.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1

ORBIT: ESCAPE / ASTEROID
AVERAGE POWER: 6500. WATTS
SIZE: DIAMETER 10.0 FT. LENGTH 20.0 FT.
DENSITY: 1.2 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1)   ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2)   ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES						1													
NEW UNITS (EXPENDABLE)						2													
OPERATION INDEPENDENT COST APPLICATION						*	*												

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**			**R&D COST ($M)**				**UNIT COST ($M)**			
	B/L	*L/C*		*BASELINE*		*LOW COST*		*BASELINE*		*LOW COST*	
SUBSYSTEM						*NO RISK*	*RISK*			*NO RISK*	*RISK*
ADAPTER	60.	125.		.680		.537	.537	.145		.109	.109
EXPERIMENT MISSION EQUIPMENT	280.	280.	(=B/L)	26.159	(=B/L)	26.159	24.328	5.090	(=B/L)	5.090	4.699
STRUCTURES AND MECHANISMS	114.	673.		4.760	(1.36)	3.247	2.857	.245		.515	.515
ELECTRICAL POWER	390.	688.		15.834	(1.75)	10.974	9.876	2.223		2.188	1.816
STABILITY & CONTROL	53.	114.		8.131		6.620	5.693	.803		.897	.826
ATTITUDE CONTROL	26.	170.		2.100		2.039	1.835	.155		.275	.275
PROPULSION	540.	540.	(=B/L)	42.100	(=B/L)	42.100	37.890	5.750	(=B/L)	5.750	5.750
TRACKING & TELEMETRY	149.	258.		24.229		26.718	24.046	3.576		3.893	3.543
ENVIRONMENTAL CONTROL	41.	90.		2.349		1.951	1.756	.425		.353	.353
EXPENDABLE PROP. & GASSES	247.	439.		.000		.000	.000	.000		.000	.000
** TOTAL **	1900.	3376.		126.338		120.344	108.818	18.399		19.059	17.884

MIN. INERT WT. EXPENDABLE P/L 1653.
MIN. TOTAL WT. EXPENDABLE P/L 1900.

REFURB. TOTAL WT. REUSEABLE P/L 679.
MIN. PROPELLANT WT. REUSEABLE P/L 335.
MIN. INERT WT. REUSEABLE P/L 2244.
MIN. TOTAL WT. REUSEABLE P/L 2579.

REFURB. INERT WT. 591.
REFURB. PROP. WT. 88.
REFURB. L/C S/S WT. 514.
L/C SUBSYSTEMS WT. 2556.
FIXED SUBSYSTEMS WT. 820.
FACTOR: (L/C-B/L-REF(L/C)) = 961.78
RATIO: INERT WT./TOTAL WT. = .87000

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	1.8311	.7325
TOTAL R&D	11.5257	4.6103
TOTAL UNIT	1.1751	.4700

R&D PHASE: 4.0 YEARS   R&D SPREAD 50% TIME AT .40 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.550 MILLION/LAUNCH, INDEPENDENT $ 3.700 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: .00 N.M.   APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 30.00 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-38. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 60

MISSION FLEMING NUMBER: 60 SUBFIELD: 0 NAME: COMET P . ENCKE/HALLEY ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NPL-18 ** (BASELINE & LOW COST) **

INCLINATION: 30.00 DEGREES
DV: 13400. FT/SEC
LIFE: 4.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 1

ORBIT: ESCAPE / COMET
AVERAGE POWER: 700. WATTS
SIZE: DIAMETER 13.0 FT. LENGTH 20.0 FT.
DENSITY: 1.3 LBS/FT3

ACCEPTABLE MISSION MODES:
** NO ** RETRIEVABLE PAYLOAD (MODE 1) ** YES ** EXPENDABLE PAYLOAD (MODE 3)
** NO ** RETRIEVABLE PAYLOAD (MODE 2) ** YES ** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES				1			1												
NEW UNITS (EXPENDABLE)				2			1												
EXPERIMENT R&D APPLICATION				*			*												
OPERATION INDEPENDENT COST APPLICATION				*	*	*	*	*	*	*									

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*		**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	70.	140.		.749		.569	.569	.153		.113	.113
EXPERIMENT MISSION EQUIPMENT	660.	660.	(=B/L)	50.000	(=B/L)	50.000	46.500	8.750	(=B/L)	8.750	8.394
STRUCTURES AND MECHANISMS	400.	1286.		8.569	(1.36)	5.522	4.859	.572		.797	.799
ELECTRICAL POWER	320.	580.		14.168	(1.79)	9.956	8.960	2.048		2.039	1.692
STABILITY & CONTROL	200.	326.		41.800		26.085	22.433	3.500		2.895	2.654
ATTITUDE CONTROL	70.	573.		3.500		3.817	3.435	.510		.703	.703
PROPULSION	0.	0.		.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	150.	259.		34.500		37.917	34.126	3.600		3.904	3.552
ENVIRONMENTAL CONTROL	50.	96.		2.750		2.165	1.949	.510		.394	.394
EXPENDABLE PROP. & GASSES	150.	306.		.000		.000	.000	.000		.000	.000
** TOTAL **	2070.	4225.		156.026		136.031	122.831	19.643		19.586	18.001

MIN. INERT WT. EXPENDABLE P/L 1920.
MIN. TOTAL WT. EXPENDABLE P/L 2070.

REFURB. TOTAL WT. REUSEABLE P/L 607.
MIN. PROPELLANT WT. REUSEABLE P/L 208.
MIN. INERT WT. REUSEABLE P/L 2668.
MIN. TOTAL WT. REUSEABLE P/L 2877.

REFURB. INERT WT. 748.
REFURB. PROP. WT. 58.
REFURB. L/C S/S WT. 681.
L/C SUBSYSTEMS WT. 3565.
FIXED SUBSYSTEMS WT. 660.
FACTOR: (L/C-B/L+REF(L/C)) = 1474.15
RATIO: INERT WT./TOTAL WT. = .92754

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	3.5000	1.4000
TOTAL R&D	13.2000	5.2800
TOTAL UNIT	1.5849	.6339

R&D PHASE: 5.0 YEARS R&D SPREAD 50% TIME AT .20 COST
NEW EXPERIMENT R&D: YES (EVERY 1 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.730 MILLION/LAUNCH, INDEPENDENT $ 4.080 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: POOR

PERIGEE ALTITUDE: .00 N.M. APOGEE ALTITUDE: .00 N.M.
INITIAL ORBIT INCLINATION: 30.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-39. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 70

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MISSION FLEMING NUMBER: 70     SUBFIELD: 0       NAME: COMSAT SATELLITE                 ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN.7                                                              ** (BASELINE & LOW COST)  **

INCLINATION: .00 DEGREES                         ORBIT: SYNCH(P)    / SYNCH(A)
*V: 14100. FT/SEC                                AVERAGE POWER:   585. WATTS
LIFE: 5.0 YEARS                                  SIZE: DIAMETER  9.0 FT.  LENGTH 22.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 4            DENSITY:   1.1 LBS/FT3

ACCEPTABLE MISSION MODES:
     ** YES**   RETRIEVABLE PAYLOAD ( MODE 1 )                    ** YES**   EXPENDABLE PAYLOAD ( MODE 3 )
     ** YES**   RETRIEVABLE PAYLOAD ( MODE 2 )                    ** YES**   EXPENDABLE PAYLOAD ( MODE 4 )

  **LAUNCH SCHEDULE: **          **YEAR**   79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
NUMBER OF LAUNCHES                          2  1  1     2  1  1        2  1
NEW UNITS (EXPENDABLE)                      2  1  1     2  1  1        2  1
NUMBER OF RETRIEVALS                                    1  1  1        2
NEW UNITS * N-R INV (REUSEABLE)             3  1  1     2
OPERATION INDEPENDENT COST APPLICATION      *  *  *  *  *  *  *  *  *  *  *  *  *  *  *

** WEIGHTS & COSTS: **        **WEIGHT (LBS)**          **R&D COST ($M)**                      **UNIT COST ($M)**
                               *B/L*   *L/C*      *BASELINE*        *LOW COST*          *BASELINE*          *LOW COST*
  **SUBSYSTEM**                                                 *NO RISK* *RISK*                        *NO RISK* *RISK*
ADAPTER                          70.    140.      .000              .000     .000       .151                .113     .113
EXPERIMENT MISSION EQUIPMENT    355.    665.      .000 ( .00)       .000     .000       2.503 (1.35)       2.091    1.934
STRUCTURES AND MECHANISMS       236.   1028.      .000 ( .00)       .000     .000       .399                .687     .687
ELECTRICAL POWER                307.    559.      .000 ( .00)       .000     .000       1.995              2.098    1.667
STABILITY & CONTROL              71.    143.      .000              .000     .000       1.100              1.160    1.068
ATTITUDE CONTROL                 61.    503.      .000              .000     .000       .430                .635     .635
PROPULSION                        0.      0.      .000              .000     .000       .000                .000     .000
TRACKING & TELEMETRY             51.     60.      .000              .000     .000       1.989              1.749    1.592
ENVIRONMENTAL CONTROL            65.    104.      .000              .000     .000       .650                .453     .453
EXPENDABLE PROP. & GASSES       273.    718.      .000              .000     .000       .000                .000     .000
   ** TOTAL **                 1490.   3921.      .000              .000     .000       9.217              8.896    8.148

  MIN. INERT WT.       EXPENDABLE P/L  1217.     REFURB. INERT WT.       612.
  MIN. TOTAL WT.       EXPENDABLE P/L  1490.     REFURB. PROP. WT.       137.          *RISK SAVINGS ($M)* *REUSE.**EXPEND.*
                                                 REFURB. L/C S/S WT.     749.               R&D EXPERIMENT    .0000     .0000
     REFURB. TOTAL WT. REUSEABLE P/L    749.     L/C SUBSYSTEMS WT.     3921.               TOTAL  R&D        .0000     .0000
  MIN. PROPELLANT WT.  REUSEABLE P/L    410.     FIXED SUBSYSTEMS WT.      0.               TOTAL  UNIT       .7484     .2994
  MIN. INERT WT.       REUSEABLE P/L   1829.     FACTOR: (L/C-B/L*REF(L/C)) = 1682.38
  MIN. TOTAL WT.       REUSEABLE P/L   2239.     RATIO: INERT WT./TOTAL WT. =  .81678

     R&D PHASE:  .0 YEARS      R&D SPREAD  50% TIME AT .00 COST
     NEW EXPERIMENT R&D: NO      ( EVERY  0 LAUNCHES )

     OPERATING COST:  DEPENDENT $  1.420 MILLION/LAUNCH,  INDEPENDENT $  2.910 MILLION/YEAR

     FIXED PORTION INITIAL INVESTMENT: $   .000 MILLION
     INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST                 P/L COST CONFIDENCE: GOOD

     PERIGEE ALTITUDE: 19323.00 N.M.                 APOGEE ALTITUDE: 19323.00 N.M.
     INITIAL ORBIT INCLINATION:  28.50 DEGREES       TUG MISSION DURATION:    .00 HOURS

     % RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%
```

Table 5-40. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 71

MISSION FLEMING NUMBER: 71   SUBFIELD: 0   NAME: U.S. DOMESTIC COMSAT   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-8   ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES   ORBIT: SYNCH(P) / SYNCH(A)
ΔV: 14100. FT/SEC   AVERAGE POWER: 900. WATTS
LIFE: 7.0 YEARS   SIZE: DIAMETER 15.0 FT. LENGTH 25.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 8   DENSITY: .8 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	2	1	1	2	2	2	2	2	2	2	2							
NEW UNITS (EXPENDABLE)	1	2	1	1	2	2	2	2	2	2	2	2							
NUMBER OF RETRIEVALS							1	2	1	1	2	1							
NEW UNITS - N-R INV (REUSEABLE)	2	2	1	1	2	2													
NEW UNITS - REC INV (REUSEABLE)							2	1		1									
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** B/L	L/C	**R&D COST ($M)** BASELINE		LOW COST NO RISK	LOW COST RISK	**UNIT COST ($M)** BASELINE		LOW COST NO RISK	LOW COST RISK
ADAPTER	120.	213.	.000		.000	.000	.180		.129	.129
EXPERIMENT MISSION EQUIPMENT	1000.	1993.	.000	(.00)	.000	.000	4.813	(1.35)	4.235	3.918
STRUCTURES AND MECHANISMS	700.	1559.	.000	(.00)	.000	.000	.833		.911	.911
ELECTRICAL POWER	850.	1353.	.000	(.00)	.000	.000	3.060		2.890	2.399
STABILITY & CONTROL	150.	259.	.000		.000	.000	2.550		2.240	2.061
ATTITUDE CONTROL	100.	759.	.000		.000	.000	.790		.875	.875
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	100.	184.	.000		.000	.000	2.880		3.238	2.946
ENVIRONMENTAL CONTROL	125.	128.	.000		.000	.000	1.200		.622	.622
EXPENDABLE PROP. & GASSES	400.	820.	.000		.000	.000	.000		.000	.000
** TOTAL **	3545.	7271.	.000		.000	.000	16.296		15.140	13.861

MIN. INERT WT.   EXPENDABLE P/L 3145.   REFURB. INERT WT. 1002.
MIN. TOTAL WT.   EXPENDABLE P/L 3545.   REFURB. PROP. WT. 127.
REFURB. L/C S/S WT. 1129.
REFURB. TOTAL WT. REUSEABLE P/L 1129.   L/C SUBSYSTEMS WT. 7271.
MIN. PROPELLANT WT. REUSEABLE P/L 527.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT.   REUSEABLE P/L 4147.   FACTOR: (L/C-B/L-REF(L/C)) = 2596.87
MIN. TOTAL WT.   REUSEABLE P/L 4674.   RATIO: INERT WT./TOTAL WT. = .88717

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	1.2796	.9118

R&D PHASE: .0 YEARS   R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.300 MILLION/LAUNCH, INDEPENDENT $ 6.720 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M.   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-41. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 72

MISSION FLEMING NUMBER: 72 SUBFIELD: 0 NAME: FOREIGN DOMESTIC COMSAT ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN-9 ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES
ΔV: 14100. FT/SEC
LIFE: 5.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 9

ORBIT: SYNCH(P) / SYNCH(A)
AVERAGE POWER: 230. WATTS
SIZE: DIAMETER 4.0 FT, LENGTH 12.0 FT,
DENSITY: 6.8 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		2	6	2	2			4	5	2	1	2							
NEW UNITS (EXPENDABLE)		2	6	2	2			4	5	2	1	2							
NUMBER OF RETRIEVALS								4	5	2	1								
NEW UNITS - N-R INV (REUSEABLE)		2	6	2	2														
NEW UNITS - REC INV (REUSEABLE)								2											
OPERATION INDEPENDENT COST APPLICATION		*	*	*	*	*	*	*	*	*	*	*	*	*	*				

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
ADAPTER	30.	73.	.000	.000	.000	.118	.093	.093
EXPERIMENT MISSION EQUIPMENT	285.	527.	.000 (.00)	.000	.000	2.188 (1.35)	1.800	1.665
STRUCTURES AND MECHANISMS	200.	947.	.000 (.00)	.000	.000	.358	.649	.649
ELECTRICAL POWER	210.	402.	.000 (.00)	.000	.000	1.722	1.753	1.455
STABILITY & CONTROL	65.	134.	.000	.000	.000	1.300	1.074	.988
ATTITUDE CONTROL	40.	315.	.000	.000	.000	.260	.442	.442
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	95.	175.	.000	.000	.000	2.8[illegible]3	3.145	2.862
ENVIRONMENTAL CONTROL	25.	76.	.000	.000	.000	.268	.261	.261
EXPENDABLE PROP. & GASSES	80.	223.	.000	.000	.000	.000	.000	.000
** TOTAL **	1030.	2872.	.000	.000	.000	8.717	9.217	8.415

MIN. INERT WT. EXPENDABLE P/L 950.
MIN. TOTAL WT. EXPENDABLE P/L 1030.

REFURB. TOTAL WT. REUSEABLE P/L 584.
MIN. PROPELLANT WT. REUSEABLE P/L 125.
MIN. INERT WT. REUSEABLE P/L 1489.
MIN. TOTAL WT. REUSEABLE P/L 1614.

REFURB. INERT WT. 539.
REFURB. PROP. WT. 45.
REFURB. L/C S/S WT. 584.
L/C SUBSYSTEMS WT. 2872.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C-B/L-REF(L/C)) = 1257.63
RATIO: INERT WT./TOTAL WT. = .92233

RISK SAVINGS ($M)	*REUSE.*	**EXPEND.*
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	.8020	.3208

R&D PHASE: .0 YEARS R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.330 MILLION/LAUNCH, INDEPENDENT $ 3.622 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 1932[illegible] N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-42. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 73

MISSION FLEMING NUMBER: 73 SUBFIELD: 0 NAME: NAV + TRAFF CONTRL SAT A •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NCN10A •• (BASELINE & LOW COST) ••

INCLINATION: 29.00 DEGREES
ΔV: 13008. FT/SEC
LIFE: 5.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 3

ORBIT: 16000NM(P) / 30000NM(A)
AVERAGE POWER: 200. WATTS
SIZE: DIAMETER 5.0 FT. LENGTH 8.0 FT.
DENSITY: 4.6 LBS/FT3

ACCEPTABLE MISSION MODES:
•• YES•• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• YES•• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	3	1	2		1		1		1		1								
NEW UNITS (EXPENDABLE)	3	1	2		1		1		1		1								
NUMBER OF RETRIEVALS						1	1		1										
NEW UNITS + N-R INV (REUSEABLE)	3	1	2		1														
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				

•• WEIGHTS & COSTS: •• ••SUBSYSTEM••	••WEIGHT (LBS)•• •B/L•	•L/C•	••R&D COST ($M)•• •BASELINE•		•LOW COST• •NO RISK•	•RISK•	••UNIT COST ($M)•• •BASELINE•		•LOW COST• •NO RISK•	•RISK•
ADAPTER	25.	63.	.000		.000	.000	.113		.089	.089
EXPERIMENT MISSION EQUIPMENT	135.	239.	.000	(.00)	.000	.000	1.356	(1.35)	1.082	1.001
STRUCTURES AND MECHANISMS	140.	773.	.000	(.00)	.000	.000	.280		.566	.566
ELECTRICAL POWER	190.	369.	.000	(.00)	.000	.000	1.653		1.692	1.404
STABILITY & CONTROL	40.	91.	.000		.000	.000	.580		.701	.645
ATTITUDE CONTROL	35.	265.	.000		.000	.000	.220		.387	.387
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	75.	131.	.000		.000	.000	2.475		2.687	2.445
ENVIRONMENTAL CONTROL	20.	71.	.000		.000	.000	.215		.224	.224
EXPENDABLE PROP. & GASSES	65.	197.	.000		.000	.000	.000		.000	.000
•• TOTAL ••	725.	2199.	.000		.000	.000	6.892		7.426	6.759

MIN. INERT WT. EXPENDABLE P/L 660.
MIN. TOTAL WT. EXPENDABLE P/L 725.

REFURB. TOTAL WT. REUSEABLE P/L 508.
MIN. PROPELLANT WT. REUSEABLE P/L 111.
MIN. INERT WT. REUSEABLE P/L 1122.
MIN. TOTAL WT. REUSEABLE P/L 1233.

REFURB. INERT WT. 462.
REFURB. PROP. WT. 46.
REFURB. L/C S/S WT. 500.
L/C SUBSYSTEMS WT. 2199.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C-B/L-REF(L/C)) = 966.44
RATIO: INERT WT./TOTAL WT. = .91034

•RISK SAVINGS ($M)•	•REUSE.•	•EXPEND.•
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	.6665	.2666

R&D PHASE: .0 YEARS R&D SPREAD 90% TIME AT .00 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.120 MILLION/LAUNCH, INDEPENDENT $ 1.960 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ 5.000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 16000.00 N.M. APOGEE ALTITUDE: 30000.00 N.M.
INITIAL ORBIT INCLINATION: 29.00 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-43. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 74

MISSION FLEWING NUMBER: 74 SUBFIELD: 0 NAME: NAV + TRAFF CONTRL SAT B ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NCN108 ** (BASELINE & LOW COST) **

INCLINATION: 5.00 DEGREES
ΔV: 14000. FT/SEC
LIFE: 5.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2

ORBIT: SYNCH(P) / SYNCH(A)
AVERAGE POWER: 200. WATTS
SIZE: DIAMETER 5.0 FT. LENGTH 8.0 FT.
DENSITY: 4.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES		1	1		1		1		1										
NEW UNITS (EXPENDABLE)		1	1		1		1		1										
NUMBER OF RETRIEVALS						1	1												
NEW UNITS + N-R INV (REUSEABLE)		2	1		1														
OPERATION INDEPENDENT COST APPLICATION		*	*	*	*	*	*	*	*	*	*	*	*						

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*	*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM								
ADAPTER	25.	25. (=B/L)	.000 (=B/L)	.000	.000	.113 (=B/L)	.113	.113
EXPERIMENT MISSION EQUIPMENT	135.	135. (=B/L)	.000 (=B/L)	.000	.000	1.356 (=B/L)	1.356	1.254
STRUCTURES AND MECHANISMS	140.	140. (=B/L)	.000 (=B/L)	.000	.000	.280 (=B/L)	.280	.280
ELECTRICAL POWER	190.	190. (=B/L)	.000 (=B/L)	.000	.000	1.653 (=B/L)	1.653	1.372
STABILITY & CONTROL	40.	40. (=B/L)	.000 (=B/L)	.000	.000	.580 (=B/L)	.580	.534
ATTITUDE CONTROL	35.	35. (=B/L)	.000 (=B/L)	.000	.000	.220 (=B/L)	.220	.220
PROPULSION	0.	0. (=B/L)	.000 (=B/L)	.000	.000	.000 (=B/L)	.000	.000
TRACKING & TELEMETRY	75.	75. (=B/L)	.000 (=B/L)	.000	.000	2.475 (=B/L)	2.475	2.252
ENVIRONMENTAL CONTROL	20.	20. (=B/L)	.000 (=B/L)	.000	.000	.215 (=B/L)	.215	.215
EXPENDABLE PROP. & GASSES	65.	65. (=B/L)	.000 (=B/L)	.000	.000	.000 (=B/L)	.000	.000
** TOTAL **	725.	725.	.000	.000	.000	6.892	6.892	6.240

MIN. INERT WT. EXPENDABLE P/L 660.
MIN. TOTAL WT. EXPENDABLE P/L 725.
REFURB. TOTAL WT. REUSEABLE P/L 308.
MIN. PROPELLANT WT. REUSEABLE P/L 111.
MIN. INERT WT. REUSEABLE P/L 1122.
MIN. TOTAL WT. REUSEABLE P/L 1233.

REFURB. INERT WT. 462.
REFURB. PROP. WT. 46.
REFURB. L/C S/S WT. 0.
L/C SUBSYSTEMS WT. 0.
FIXED SUBSYSTEMS WT. 725.
FACTOR: (L/C=B/L=REF(L/C)) = =1.00
RATIO: INERT WT./TOTAL WT. = .91034

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	.6519	.2607

R&D PHASE: .0 YEARS R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.120 MILLION/LAUNCH, INDEPENDENT $ 1.708 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS INVESTMENT SPREAD: 50% TIME AT .50 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 19323.00 N.M. APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-44. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 75

MISSION FLEMING NUMBER: 75 SUBFIELD: 0 NAME: TOS METEOROLOGICAL SAT. ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: MEO-7 ** (BASELINE & LOW COST) **

INCLINATION:100,70 DEGREES ORBIT: 700M(P) / 700M(A)
ΔV: 1900, FT/SEC AVERAGE POWER: 200, WATTS
LIFE: 4,0 YEARS SIZE: DIAMETER 5,0 FT, LENGTH 6,0 FT,
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 5 DENSITY: 8,7 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1) ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2) ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	'	1	1							
NUMBER OF RETRIEVALS					1	1	1	1	1	\	1								
NEW UNITS - N-R INV (REUSEABLE)	1	1	1	1	1														
OPERATION INDEPENDENT COST APPLICATION	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				

** WEIGHTS & COSTS: **	**WEIGHT (LBS)**		**R&D COST ($M)**			**UNIT COST ($M)**		
	B/L	*L/C*	*BASELINE*	*LOW COST*		*BASELINE*	*LOW COST*	
SUBSYSTEM				*NO RISK*	*RISK*		*NO RISK*	*RISK*
ADAPTER	30,	73,	,000	,000	,000	,118	,093	,093
EXPERIMENT MISSION EQUIPMENT	250,	459,	,000 (,00)	,000	,000	2,600 (1,90)	2,317	2,143
STRUCTURES AND MECHANISMS	200,	947,	,000 (,00)	,000	,000	,358	,649	,649
ELECTRICAL POWER	270,	500,	,000 (,00)	,000	,000	1,917	1,918	1,592
STABILITY & CONTROL	60,	125,	,000	,000	,000	,920	1,001	,921
ATTITUDE CONTROL	30,	213,	,000	,000	,000	,185	,327	,327
PROPULSION	0,	0,	,000	,000	,000	,000	,000	,000
TRACKING & TELEMETRY	90,	165,	,000	,000	,000	2,745	3,045	2,771
ENVIRONMENTAL CONTROL	20,	71,	,000	,000	,000	,215	,224	,224
EXPENDABLE PROP, & GASSES	80,	215,	,000	,000	,000	,000	,000	,000
** TOTAL **	1030,	2768,	,000	,000	,000	9,258	9,574	8,720

MIN, INERT WT, EXPENDABLE P/L 950, REFURB, INERT WT, 539,
MIN, TOTAL WT, EXPENDABLE P/L 1030, REFURB, PROP, WT, 45,
REFURB, L/C S/S WT, 584,
REFURB, TOTAL WT, REUSEABLE P/L 584, L/C SUBSYSTEMS WT, 2768,
MIN, PROPELLANT WT, REUSEABLE P/L 125, FIXED SUBSYSTEMS WT, 0,
MIN, INERT WT, REUSEABLE P/L 1489, FACTOR: (L/C-B/L-REF(L/C)) = 1194,22
MIN, TOTAL WT, REUSEABLE P/L 1614, RATIO: INERT WT,/TOTAL WT, = ,92233

RISK SAVINGS ($M)	*REUSE,*	*EXPEND,*
R&D EXPERIMENT	,0000	,0000
TOTAL R&D	,0000	,0000
TOTAL UNIT	,8940	,3416

R&D PHASE: ,0 YEARS R&D SPREAD 50% TIME AT ,00 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1,430 MILLION/LAUNCH, INDEPENDENT $ 2,688 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $,000 MILLION
INVESTMENT PHASE: 2,00 YEARS INVESTMENT SPREAD: 50% TIME AT ,50 COST P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 700,00 N,M, APOGEE ALTITUDE: 700,00 N,M,
INITIAL ORBIT INCLINATION: 100,70 DEGREES TUG MISSION DURATION: ,00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100,% AND IN MODE 2 = 100,%

Table 5-45. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 76

MISSION FLEMING NUMBER: 76   SUBFIELD: 0   NAME: SYNC METEOROLOGICAL SAT   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEO-15   ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES   ORBIT: SYNCH(P) / SYNCH(A)
ΔV: 14100. FT/SEC   AVERAGE POWER: 300. WATTS
LIFE: 2.0 YEARS   SIZE: DIAMETER 5.0 FT. LENGTH 6.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 2   DENSITY: 6.6 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	1	1	1	1	1	1	1	1	1	1	1	1							
NEW UNITS (EXPENDABLE)	1	1	1	1	1	1	1	1	1	1	1	1							
NUMBER OF RETRIEVALS			1	1	1	1	1	1	1	1	1								
NEW UNITS + N-R INV (REUSEABLE)	1	1	1																
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•	•	•	•	•	•						

** WEIGHTS & COSTS: ** **SUBSYSTEM**	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
ADAPTER	35.	82.	.000		.000	.000	.124		.096	.096
EXPERIMENT MISSION EQUIPMENT	250.	459.	.000	(.00)	.000	.000	2.850	(1.90)	2.317	2.143
STRUCTURES AND MECHANISMS	160.	839.	.000	(.00)	.000	.000	.307		.598	.598
ELECTRICAL POWER	250.	468.	.000	(.00)	.000	.000	1.650		1.866	1.549
STABILITY & CONTROL	70.	142.	.000		.000	.000	1.093		1.146	1.054
ATTITUDE CONTROL	50.	409.	.000		.000	.000	.340		.541	.541
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	100.	184.	.000		.000	.000	2.880		3.238	2.946
ENVIRONMENTAL CONTROL	30.	81.	.000		.000	.000	.320		.293	.293
EXPENDABLE PROP. & GASSES	90.	254.	.000		.000	.000	.000		.000	.000
** TOTAL **	1035.	2916.	.000		.000	.000	9.761		10.094	9.220

MIN. INERT WT. EXPENDABLE P/L 945.   REFURB. INERT WT. 519.
MIN. TOTAL WT. EXPENDABLE P/L 1035.   REFURB. PROP. WT. 49.
REFURB. L/C S/S WT. 569.
REFURB. TOTAL WT. REUSEABLE P/L 569.   L/C SUBSYSTEMS WT. 2916.
MIN. PROPELLANT WT. REUSEABLE P/L 139.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1464.   FACTOR: (L/C-B/L+REF(L/C)) = 1312.22
MIN. TOTAL WT. REUSEABLE P/L 1604.   RATIO: INERT WT./TOTAL WT. = .91304

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	.8741	.3496

R&D PHASE: .0 YEARS   R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.500 MILLION/LAUNCH, INDEPENDENT $ 2.467 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M.   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.%   AND IN MODE 2 = 100.%

Table 5-46. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 77

MISSION FLEMING NUMBER: 77 SUBFIELD: 0 NAME: POLAR EARTH RESOURC SAT •• MISSION / PAYLOAD DATA ••
MISSION CODE NUMBER: NEO-17 •• (BASELINE & LOW COST) ••

INCLINATION: 99.15 DEGREES
ΔV: 1350. FT/SEC
LIFE: 2.0 YEARS
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 4

ORBIT: 500NM(P) / 500NM(A)
AVERAGE POWER: 600. WATTS
SIZE: DIAMETER 12.0 FT. LENGTH 15.0 FT.
DENSITY: 1.5 LBS/FT3

ACCEPTABLE MISSION MODES:
•• YES•• RETRIEVABLE PAYLOAD (MODE 1) •• YES•• EXPENDABLE PAYLOAD (MODE 3)
•• YES•• RETRIEVABLE PAYLOAD (MODE 2) •• YES•• EXPENDABLE PAYLOAD (MODE 4)

••LAUNCH SCHEDULE: •• ••YEAR••	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES	4		4		4		4				6								
NEW UNITS (EXPENDABLE)	4		4		4		4				6								
NUMBER OF RETRIEVALS			4		4		4		2										
NEW UNITS + N-R INV (REUSEABLE)	4		4																
OPERATION INDEPENDENT COST APPLICATION	•	•	•	•	•	•	•	•			•	•							

•• WEIGHTS & COSTS: ••	••WEIGHT (LBS)••		••R&D COST ($M)••			••UNIT COST ($M)••		
	•B/L•	•L/C•	•BASELINE•	•LOW COST•		•BASELINE•	•LOW COST•	
••SUBSYSTEM••				•NO RISK•	•RISK•		•NO RISK•	•RISK•
ADAPTER	93.	171.	.003	.000	.000	.165	.120	.120
EXPERIMENT MISSION EQUIPMENT	850.	1678.	.003 (.00)	.000	.000	6.270 (1.90)	5.336	4.936
STRUCTURES AND MECHANISMS	370.	1240.	.000 (.00)	.000	.000	.544	.783	.783
ELECTRICAL POWER	600.	1000.	.000 (.00)	.000	.000	2.652	2.552	2.118
STABILITY & CONTROL	200.	326.	.000	.000	.000	3.500	2.885	2.654
ATTITUDE CONTROL	80.	643.	.000	.000	.000	.600	.769	.769
PROPULSION	0.	0.	.000	.000	.000	.000	.000	.000
TRACKING & TELEMETRY	180.	293.	.000	.000	.000	3.960	4.174	3.798
ENVIRONMENTAL CONTROL	60.	101.	.000	.000	.000	.610	.434	.434
EXPENDABLE PROP. & GASSES	160.	359.	.000	.000	.000	.000	.000	.000
•• TOTAL ••	2590.	5819.	.000	.000	.000	18.301	17.053	15.613

MIN. INERT WT. EXPENDABLE P/L 2430.
MIN. TOTAL WT. EXPENDABLE P/L 2590.

REFURB. TOTAL WT. REUSEABLE P/L 825.
MIN. PROPELLANT WT. REUSEABLE P/L 211.
MIN. INERT WT. REUSEABLE P/L 3204.
MIN. TOTAL WT. REUSEABLE P/L 3415.

REFURB. INERT WT. 774.
REFURB. PROP. WT. 51.
REFURB. L/C S/S WT. 825.
L/C SUBSYSTEMS WT. 5819.
FIXED SUBSYSTEMS WT. 0.
FACTOR: (L/C-B/L-REF(L/C)) = 2403.29
RATIO: INERT WT./TOTAL WT. = .93822

•RISK SAVINGS ($M)•	•REUSE.•	•EXPEND.•
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0000	.0000
TOTAL UNIT	1.4405	.5762

R&D PHASE: .0 YEARS R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 2.500 MILLION/LAUNCH, INDEPENDENT $ 6.000 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 3.00 YEARS INVESTMENT SPREAD: 50% TIME AT .90 COST P/L COST CONFIDENCE: FAIR

PERIGEE ALTITUDE: 500.00 N.M. APOGEE ALTITUDE: 500.00 N.M.
INITIAL ORBIT INCLINATION: 99.15 DEGREES TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%

Table 5-47. PAYLOAD COSTS AND CHARACTERISTICS FOR MISSION NO. 78

MISSION FLEMING NUMBER: 78   SUBFIELD: 0   NAME: SYNC EARTH RESOURCES SAT   ** MISSION / PAYLOAD DATA **
MISSION CODE NUMBER: NEO-11   ** (BASELINE & LOW COST) **

INCLINATION: .00 DEGREES   ORBIT: SYNCH(P) / SYNCA(A)
ΔV: 14100. FT/SEC   AVERAGE POWER: 400. WATTS
LIFE: 3.0 YEARS   SIZE: DIAMETER 6.0 FT. LENGTH 6.0 FT.
NUMBER OF ACTIVE PAYLOADS ON ORBIT: 4   DENSITY: 6.1 LBS/FT3

ACCEPTABLE MISSION MODES:
** YES** RETRIEVABLE PAYLOAD (MODE 1)   ** YES** EXPENDABLE PAYLOAD (MODE 3)
** YES** RETRIEVABLE PAYLOAD (MODE 2)   ** YES** EXPENDABLE PAYLOAD (MODE 4)

LAUNCH SCHEDULE: ** **YEAR	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
NUMBER OF LAUNCHES								4			4								
NEW UNITS (EXPENDABLE)								4			4								
NUMBER OF RETRIEVALS											3								
NEW UNITS - N-R INV (REUSEABLE)								5											
OPERATION INDEPENDENT COST APPLICATION								*	*	*	*	*	*						

** WEIGHTS & COSTS: **	**WEIGHT (LBS)** *B/L*	*L/C*	**R&D COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*	**UNIT COST ($M)** *BASELINE*		*LOW COST* *NO RISK*	*RISK*
SUBSYSTEM										
ADAPTER	30.	73.	.000		.000	.000	.116		.093	.093
EXPERIMENT MISSION EQUIPMENT	350.	655.	.000	(.00)	.000	.000	3.515	(1.00)	2.915	2.696
STRUCTURES AND MECHANISMS	150.	807.	.000	(.00)	.000	.000	.298		.542	.387
ELECTRICAL POWER	200.	385.	.000	(.00)	.000	.000	1.695		1.723	1.430
STABILITY & CONTROL	65.	134.	.000		.000	.000	1.000		1.074	.988
ATTITUDE CONTROL	40.	315.	.000		.000	.000	.260		.442	.442
PROPULSION	0.	0.	.000		.000	.000	.000		.000	.000
TRACKING & TELEMETRY	95.	175.	.000		.000	.000	2.803		3.145	2.862
ENVIRONMENTAL CONTROL	20.	71.	.000		.000	.000	.215		.224	.224
EXPENDABLE PROP. & GASSES	80.	220.	.000		.000	.000	.000		.000	.000
** TOTAL **	1030.	2835.	.000		.000	.000	9.899		10.197	9.317

MIN. INERT WT. EXPENDABLE P/L 950.   REFURB. INERT WT. 514.
MIN. TOTAL WT. EXPENDABLE P/L 1030.   REFURB. PROP. WT. 43.
REFURB. L/C S/S WT. 557.
REFURB. TOTAL WT. REUSEABLE P/L 557.   L/C SUBSYSTEMS WT. 2835.
MIN. PROPELLANT WT. REUSEABLE P/L 123.   FIXED SUBSYSTEMS WT. 0.
MIN. INERT WT. REUSEABLE P/L 1464.   FACTOR: (L/C-B/L-REF(L/C)) = 1247.78
MIN. TOTAL WT. REUSEABLE P/L 1587.   RATIO: INERT WT./TOTAL WT. = .92233

RISK SAVINGS ($M)	*REUSE.*	*EXPEND.*
R&D EXPERIMENT	.0000	.0000
TOTAL R&D	.0009	.0030
TOTAL UNIT	.8884	.3522

R&D PHASE: .0 YEARS   R&D SPREAD 50% TIME AT .00 COST
NEW EXPERIMENT R&D: NO   (EVERY 0 LAUNCHES)

OPERATING COST: DEPENDENT $ 1.920 MILLION/LAUNCH, INDEPENDENT $ 3.160 MILLION/YEAR

FIXED PORTION INITIAL INVESTMENT: $ .000 MILLION
INVESTMENT PHASE: 2.00 YEARS   INVESTMENT SPREAD: 50% TIME AT .50 COST   P/L COST CONFIDENCE: GOOD

PERIGEE ALTITUDE: 19323.00 N.M.   APOGEE ALTITUDE: 19323.00 N.M.
INITIAL ORBIT INCLINATION: 28.50 DEGREES   TUG MISSION DURATION: .00 HOURS

% RETRIEVED PAYLOAD WEIGHT: IN MODE 1 = 100.% AND IN MODE 2 = 100.%